AN EVALUATION OF THE COGNITION COMPONENT OF THE PHYSICS RESOURCES AND INSTRUCTIONAL STRATEGIES FOR MOTIVATING STUDENTS (PRISMS) PROGRAM IN IOWA

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by

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The problem. The problem of this study was to determine whether the Physics Resources and Instructional Strategies for Motivating Students (PRISMS) program influenced the teachers' knowledge of physics.

Procedures. Data for this study were collected through pre- and post-questionnaires for twenty-nine teachers and administrators. Pre- and post-assessment instruments were developed to measure the teachers' knowledge of physics content. The purpose for these data collection instruments was to determine if the PRISMS program could contribute to the improvement of physics instruction in Iowa. The data gathered from these instruments tested the hypotheses. The paired-t test examined the change in scores for Hypotheses 3, 4, 5, and 6. Pearson's Product Moment correlation was calculated for the remaining hypotheses in an attempt to determine if relationships existed between major study variables. Descriptive statistics were applied to selected items on the questionnaires as a means of examining changes in opinion scores for teachers and administrators.

Findings. The data indicated that the teachers' attitudes toward teaching physics and the PRISMS program decreased from a positive attitude to a less positive attitude. The teachers' knowledge of physics increased as a result of PRISMS, and the teachers became more comfortable with presenting physics concepts. The teachers' level of knowledge was influenced by years in teaching physics, and by the number of semester hours taken in college physics. The data indicated that the administrators' pre-program attitudes influenced the teachers' level of knowledge. Finally, the teachers' and administrators' opinions on selected statements decreased from a more positive opinion to a somewhat negative opinion.

Conclusion. The results of this study were not sufficient to indicate that the PRISMS program improved physics instruction in Iowa.

Recommendations. It is recommended that: (1) researchers investigate the effect that the PRISMS program would have on student learning, (2) comparisons between student achievement scores for districts not utilizing PRISMS be conducted, and (3) researchers must investigate the causes for the decreases in teachers' attitudes and opinions.

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CHAPTER ONE

Introduction

In recent years, the field of science, particularly science education, has undergone several major changes. These changes have had a direct effect on the direction, methods, and the funding within science education. The impetus for many of these initial changes came as a result of the launching of Sputnik I by the Russians in 1957.[1]

The reaction displayed by the American public and by private industry to this launching was such that the National Science Foundation (NSF), and the Federal government increased their financial support for science and mathematics education to unprecedented levels.[2] The National Science Foundation became extensively involved in the development of instructional materials, and teacher improvement programs. The increased funding allowed colleges and universities to refine and update their science

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[1]Lazer Goldberg, Children and Science (New York: Charles Scribner's Sons, 1970), p. 1.

[2]Ghazi R. Audeh, "A Longitudinal Study of Science Curriculum and Practices in Elementary Schools in 10 States (1970-1980)," Diss. Ohio State Univ., 1982, p. 4.

and mathematics curriculums.[1]

The changes at the university level were intended to produce highly skilled and qualified scientists, technicians, and mathematicians. Unfortunately, for science education, these newly trained graduates have been vigorously sought after by the government and private industry. Since these non-educational institutions were drawing prospective science teachers away from the classroom, a question arose in the minds of those responsible for science education as to how could one keep and draw qualified personnel into the teaching profession and at the same time impede the impending shortage of science teachers?[2]

In response to this question, the Iowa Department of Public Instruction (DPI) was assigned the task by Governor Ray to study and suggest remedies for Iowa's critical shortage of science teachers. In October, 1981, the DPI initiated a physics task force to address the staff and curriculum problems that are unique to physics (see Appendix A).[3]

In addition, the Governor's Science Advisory Council

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[1]Stanley Helgeson, P. E. Blosser, and R. W. Howe, "The Status of Pre-College Science, Mathematics, and Social Studies Education: 1955-1975," Science Education Information Reports (Columbus: ERIC Clearinghouse, 1977), pp. 17-24.

[2]Personal interview with Jack Gerlovich, state science consultant for Iowa, 1 March 1983.

[3]Personal interview with Jack Gerlovich, 8 February 1984.

(GSAC) and the Iowa Academy of Science (IAS) formed the Ad Hoc Education Committee in June, 1982 (see Appendix B).[1] Chaired by Dr. Jack Gerlovich, the education committee studied and categorized the problems related to the supply and demand for science teachers in Iowa, and it proposed solutions to these problems.[2]

In a summary report to the governor, Gerlovich and the Education Committee stated:

> The study recognizes the need for an improved science curriculum throughout grades K-12, and higher graduation requirements in science and mathematics in secondary schools....the current supply of teachers in secondary physical science and mathematics is inadequate to staff the existing minimal course requirements....adequately trained science and mathematics teachers are leaving the classroom at a rapid rate to take non-teaching positions.[3]

By January 1983, the physics task force had developed four physics units which were pilot-tested in Area Education Association 15 in Southeast Iowa.[4] As a result of this

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[1]Minutes from the Ad Hoc Education Committee (Des Moines: Department of Public Instruction, 21 Sept. 1982), pp. 1-3.

[2]Jack Gerlovich and Roy Unruh, "Upgrading Physics Teachers and Curriculum Through Application of Technology" (Des Moines: Department of Public Instruction, 1983), p. 5. (Mimeographed)

[3]Jack Gerlovich and others, "The Crisis in Science and Mathematics Education in Iowa: The Problem and Recommendations" (Des Moines: Governor's Science Advisory Council and the Iowa Academy of Science, Oct. 1982), p. 1. (Mimeographed)

[4]Gerlovich and Unruh, pp. 5-6.

initial curriculum endeavor, and with the support from GSAC and IAS, the task force developed the Physics Resources and Instructional Strategies for Motivating Students (PRISMS) program in Iowa.

Statement of the Problem

Since the PISMS program is experimental in nature and represents a new concept in teacher preparation, no base line data exists which reports on the effectiveness of such a program. While PRISMS has the twofold purpose of improving teaching strategies in physics and students' attitudes toward physics, the problem of this study is to determine if PRISMS improves the teachers' knowledge of physics.

Purpose of the Study

The purpose of this study is to see whether PRISMS could contribute to the improvement of physics instruction in the state of Iowa.

Methodology

In an attempt to find a solution to the problem proposed in this study, specific data collection instruments were developed. The instruments consisted of pre-questionnaires and post-questionnaires for teachers and administrators. The questionnaires were designed to elicit the teachers' and administrators' opinions and attitudes, as well as the teachers' level of comfort in presenting physics concepts.

In addition, a pre-assessment and post-assessment form was designed to measure the teachers' knowledge of physics content. The paired t-test, Pearson's r, and descriptive statistics were applied to the data. The significance levels were determined to be .01 and .05.

Questions to be Answered

1. Will there be changes in the teachers' attitudes toward teaching physics?

2. Will this program increase the non-physics teachers' knowledge of physics concepts?

3. Are the perceptions of teachers and administrators the same toward this type of program?

4. Will there be changes in the administrators' attitudes toward physics?

5. Do relationships exist between the teachers' attitudes and the level of knowledge, level of comfort, hours of college physics, and the number of years in teaching?

6. Are there relationships between the administrators' attitudes toward physics and the teachers' level of comfort, level of knowledge, years teaching physics, and the teachers' attitudes toward teaching physics?

7. Will there be a change in the teachers' level of comfort toward presenting physics concepts?

Statement of the Hypotheses

In an attempt to answer the questions of this study, the following hypotheses were tested:

1. There is no relationship between the number of years teaching physics and the level of comfort in presenting physics concepts after program implementation.

2. There is no relationship between the teachers' attitudes toward teaching physics and the level of comfort in presenting concepts related to physics after program implementation.

3. There is no difference in the administrators' attitudes toward utilizing this training program as a result of program implementation.

4. There is no difference in the teachers' attitudes toward teaching physics before and after program implementation.

5. There is no difference in the teachers' level of knowledge of physics concepts following program implementation.

6. There is no difference in the teachers' level of comfort with presenting physics concepts before and after program implementation.

7. There is no relationship between the teachers' level of knowledge of physics and the level of comfort after program implementation.

8. There is no relationship between the teachers' attitudes toward physics and the level of knowledge of physics concepts after program implementation.

9. There is no relationship between administrator and teacher attitude gain scores resulting from program implementation.

10. There is no relationship between the administrators' post-program attitudes and the teachers' post-program level of comfort in presenting physics concepts.

11. There is no relationship between the administrators' pre-program attitudes and the teachers' gain in knowledge level of physics concepts.

12. There is no relationship between the teachers' number of years teaching physics and teachers' attitudes toward teaching physics after program implementation.

13. There is no relationship between the number of years teaching physics and the teachers' gain in knowledge level of physics concepts.

14. There is no relationship between the teachers' years in teaching physics and the administrators' attitudes toward this program before program implementation.

15. There is no relationship between the teachers' hours of college physics and the teachers' attitudes toward this program before program implementation.

16. There is no relationship between the teachers' hours of college physics and the teachers' level of comfort in presenting physics concepts before program implementation.

17. There is no relationship between the teachers' hours of college physics and the teachers' level of comfort in presenting physics concepts after program implementation.

18. There is no relationship between the teachers' hours of college physics and the teachers' level of knowledge of physics concepts after program implementation.

19. There is no relationship between the teachers' hours of college physics and the administrators' attitudes toward this program before program implementation.

Significance of the Study

Since the PRISMS program represents a new concept in teacher preparation, this study will generate new base line data. In addition, the PRISMS program is an attempt to provide a possible solution to Iowa's physics teacher shortage and to provide a useful resource for the physics teacher.

Definition and Description of Terms

The term non-physics teacher refers to teachers who have taken a minimum of three hours of college physics but hold a degree in a field other than physics.

The phrase telecommunications delivery system refers to a process utilizing the Iowa Regent's Telebridge telephone network to connect a university professor with teachers in their classrooms. This process requires that each classroom be fitted with both a telephone and speaker-phone for interactive participation.

Physics Resources and Instructional Strategies for Motivating Students (PRISMS) refers to a pilot program currently being tested in the state of Iowa. The program is designed to help non-physics teachers to teach physics and is a technologically updated resource for current physics teachers.

The PRISMS program provides the teacher with materials and activities which present major concepts in physics as they relate to common life experiences. The activities are intended to develop the students' problem solving and reasoning skills, relate physics to societal concerns, and supply information about careers related to physics and its application.[1]

The phrase level of comfort refers to teachers who express a confident attitude toward presenting physics concepts because of the number of hours taken in college physics, and/or as a result of participating in the PRISMS program.

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[1] Jack Gerlovich, Roy Unruh and others, Physics Resources and Instructional Strategies for Motivating Students (Des Moines: Iowa Department of Public Instruction, Aug. 1983).

The term <u>attitude(s)</u> is defined as the predisposition or manner indicative of feelings, knowledge, and behavior toward a person or thing.

The term <u>opinion(s)</u> is defined as the covert behavior resulting from a specific attitude or set of attitudes.

Limitations of the Study

The results and conclusions of this study will be limited to the twenty-nine teachers and twenty-nine administrators selected for participation by their Area Education Association (AEA) science consultants. Because the participants were selected by AEA consultants and not drawn randomly from a larger population, caution should be used in any generalization beyond the sample.

Summary

In this chapter, the problem, purpose, and methodology of the study were described, questions to be answered were provided, the hypotheses and significance were stated, and the definition, description, and limitations were given. Chapter Two will present a review of related literature. Chapter Three will describe the methodology to be used in presenting the data. Chapter Four will present and analyze the data, and Chapter Five will report the summary, findings, conclusions, discussion, and further recommendations.

CHAPTER TWO

Review of Related Literature

Introduction

In an address to the National Academy of Science and the National Academy of Engineering, President Reagan stated:

> The problems today in elementary and secondary school science and mathematics education are serious--serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international market places. Failure to remain at the industrial forefront results in direct harm to our American economy and standard of living.[1]

In this address, the president was expressing a growing concern that is being articulated by science educators and science leaders throughout America. The problems confronting science education today have evolved over three decades of curriculum reform and are presenting educators with serious curricular and staffing alternatives.[2]

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[1] Science and Mathematics in the Schools: Report of a Convocation, National Academy of Science and National Academy of Engineering (Washington, D.C.: National Academy Press, May 1982), p. 2.

[2] Personal interview with Jack Gerlovich, 9 Jan. 1984.

Science Education - 1950-1980: A K-12 Overview

Science curriculums up to, and including, the early 1950's had remained relatively unchanged since the mid-1800's. The curriculum materials for most science or mathematics courses during that time had been the textbook and the teacher. World War II, however, created such an influx of new technology that science publishers found it very difficult to keep textbooks current and scientifically relevant to the needs of society. In addition, the cold war between the United States and Russia emphasized the importance of education and training specialists in science, mathematics, and engineering.[1] As a result, a growing concern for science education began to surface. The impetus for this concern was directly related to national security and the progress that the Russians were making technologically.[2]

Between the years of 1950 and 1954, interest and support for high school, undergraduate, and graduate science programs increased substantially. In 1953, the National Science Foundation (NSF) initiated its first effort at improving science instruction. During the summer of 1953, the foundation conducted two institutes for college-level

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[1]Christopher Dede and Joy Hardin, "Reforms, Revisions, Reexaminations: Secondary Science Education Since World War II," Science Education, 57, No. 4 (Oct.-Dec. 1973), 485.

[2]Helgeson, Blosser, and Howe, p. 22.

science and mathematics educators. The success of these initial programs prompted the first high school level institute during the summer of 1954. The main intent of these institutes was to update the teacher's experience with science and technology, and to initiate curriculum development.[1]

On October 4, 1957, Russia launched Sputnik I. This display of technological and scientific achievement outraged the American public. This outpouring of public opinion provided the impetus for the federal government and the educational organizations responsible for science to step-up their efforts at improving science education.[2] With the passing of the Cooperative Research Act (CRA), the Elementary and Secondary Education Act (ESEA), and the National Defense Act (NDA), the National Science Foundation (NSF) and governmental agencies became extensively involved in the development of instructional materials.[3]

The extent to which NSF became involved in curriculum development activities is evidenced by its expenditures of funds. Audeh found that between 1952 and 1975, NSF expended

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[1] Robert Stake and J. Easley, Case Studies in Science Education, 2 (Urbana: Center for Instructional Research and Curriculum Evaluation, Univ. of Illinois, Jan. 1978), pp. 28-29.

[2] Helgeson, Blosser, and Howe, pp. 23-24.

[3] Ibid.

more than $1.6 billion in an effort to improve science instruction.[1] The post-Sputnik curricular reform activities in elementary and secondary science were generally directed toward teacher training programs, new curriculums, and improving laboratory activities. In addition, much of the NSF's funded activities was aimed at developing more textbooks in the traditional disciplines of physical and biological sciences: improving teachers' knowledge of physics, chemistry, earth science, and biology.[2]

The curriculum reform attempts over the past three decades have had distinct characteristics that have been categorized by Dede and Hardin.[3] They contend that the reform efforts fall into one of the three following categories:

> Traditional - Materials which emphasized how the needs of the students and society could be fulfilled by the teacher. It neglected scholarship and the subject discipline. It generally refers to material written before 1956.
>
> First Generation - Materials which emphasized scholarship and the discipline, but neglected the needs of the student and society. It generally refers to materials written from the late 1950's to the mid-1960's.
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> Second Generation - Materials which combined the best qualities of the traditional and first generation reforms by attempting to orient disciplined-based materials somewhat towards the needs of the

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[1]Audeh, pp. 4-5.

[2]Rodger Bybee and others, "Science, Society, and Science Education," Science Education, 64, No. 3 (July 1980), 378.

[3]Dede and Hardin, pp. 488-89.

> students, teachers, and society. It generally refers to materials written from the mid-1960's to the mid-1970's.[1]

Factors Affecting Curriculum Development

During the first attempts at curriculum reform, Jerome Bruner came to the forefront of the reform movement with the publishing of The Process of Education. It was Bruner's concepts of learning and how students learn that began to shape the direction of the first generation materials from an emphasis on "pure" science to a form that developed the needs of the students and society into the science program itself.[2]

Bruner believed that knowledge was the dominant aim of education, and the learning method was the means by which this aim was achieved. Bruner emphasized that the methods being used were not achieving the desired goals, but believed that learning came as a result of discovery, inquiry, and through problem-solving and not through programmed instruction.[3] He stated:

> It is only through the exercise of problem-solving and the effect of discovery that one learns the working heuristic of discovery, and

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[1]Dede and Hardin, pp. 488-89.

[2]Rodger Bybee, "The New Transformation of Science Education," Science Education, 61, No. 1 (Jan.-March 1977), 90.

[3]Jerome Bruner, The Process of Education (New York: Vintage Books, 1960).

> the more one has practice, the more likely is one to generalize that one has learned into a style of problem-solving or inquiry that serves for any kind of task. . . practice in inquiry. . . is needed.[1]

In addition to Bruner's work, which had a major impact on all levels of curriculum development, there began in the early 1960's an underlying current of discontent with the educational process in general. Political and racial unrest, and the Viet Nam War began to affect the production and design of scientific curricula. The traditional indices of academic quality came into question as students criticized the methods of teaching as being dehumanizing and insensitive.[2]

The Sixties and Seventies were years of change and turmoil for those responsible for science education. The financial expenditures for the Viet Nam War and the new awareness of environmental concerns, as well as the social issues were drawing on funds that once were being used for curriculum development. Funding became such a critical issue, according to Greenleaf and Griffin, that NSF suspended the teacher education programs during 1975-76, and sharply curtailed or stopped most of the curriculum development

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[1]Jerome Bruner, "The Act of Discovery," Harvard Education Review, 30, No. 1 (Winter 1961), 31.

[2]Warren Greenleaf and G. A. Griffin, Schools for the 70's and Beyond: A Call to Action (Washington, D.C.: National Education Association, Feb. 1971), p. 47.

projects.[1] In fact, Klein indicated that in 1959, the 72 percent of the education budget, allocated for development projects, dropped to only 22 percent in 1980.[2]

Between the years 1950 and 1975, NSF not only expended an unprecedented amount of money, but it produced or supported some 750 different programs.[3] It is beyond the scope of this research to identify each program. It may be beneficial, however, to review the elementary and secondary disciplines, and the major programs that came from the curriculum reform movements.

Elementary Science Education (K-8)

Studies by Ayers and Ayers have indicated that prior to the reform movement years the attitudes and philosophies toward elementary science education had been somewhat indifferent. The research by Ayers and Ayers has indicated, however, that during the reform's initial years, educators began to view elementary science as an effective means of

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[1]Norris Harms and R. Yager, What Research Says to the Teacher, 3 (Washington, D.C.: National Science Teachers Association, 1981), p. 2.

[2]Sarah Klein, Testimony to Committee on Labor and Human Resources of the United States Senate in Regard to 1983 Authorization for the Science Education Component of the National Science Foundation (Washington, D.C.: National Science Teachers Association, April 1982), p. 10.

[3]National Science Foundation - Supported Science Education Materials: Problems in Evaluation, Distribution, and Monitoring (Washington, D.C.: GPO, 1976), p. 5.

developing scientific literacy at an early age. In addition, there was mounting evidence showing that early experiences in science were not only important for the development of the child's approach to life as an active thinker, but they added a new dimension to his/her world.[1]

Simpson's research supported this concept by indicating that if students did not have a positive experience with science during the early grades they may be more inclined to take only the minimal science requirements at the secondary level.[2]

It was during the early 1960's that the theories of Bruner[3] and Piaget,[4] and the taxonomy of Bloom[5] began to influence the structure of elementary and junior high science materials. During this time the emphasis that had been placed on "pure" science was changing to an emphasis based on fundamental learning skills. Wellman cited evidence

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[1] J. B. Ayers and M. N. Ayers, "Influences of SAPA on Kindergarten Children's Use of Logic in Problem Solving," School Science and Mathematics, 73 (Dec. 1973), 770.

[2] R. D. Simpson, Relating Student Feelings to Achievement in Science (Washington, D.C.: National Science Teachers Association, 1978), pp. 40-54.

[3] Bruner, The Process of Education.

[4] Jean Piaget, Science of Education and the Psychology of the Child (New York: Orion Press, 1970).

[5] B. S. Bloom, Taxonomy of Educational Objectives, the Classification of Educational Goals (New York: David McKay, 1964).

which indicates that the study of science at the elementary and junior high level involving organization and interpretation skills aided students in developing their language and reading competency.[1]

Since science education at the early levels, especially at the elementary level, became such an issue, the role of the science teacher became the focus of educational debate. Research conducted by NSF and the Office of Education (OE) indicated that the classroom teacher plays a pivotal role in the education of their students. The experience that the students have in regard to science may be a direct result of the teachers' attitudes and abilities when presenting science concepts.[2]

In relation to the teachers' attitudes, Horn and James found, in general, that elementary teachers did not appear to value the teaching of science and failed to see the significance of having elementary students become scientifically literate. This apparent lack of concern seems to be a result of inadequate training to teach science, lack of planning time, inadequate time to teach science, and a lack of interest by the teacher all of which had a major influence

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[1] T. R. Wellman, Science: A Basic for Language and Reading Development (Washington, D.C.: National Science Teachers Association, 1978), pp. 11-12.

[2] "Education for the 1980's and Beyond," Science and Engineering (Washington, D.C.: National Science Foundation and Office of Education, Oct. 1980), pp. 48-49.

on science education.[1]

Gerlovich, Downs, and Magrane contend that this problem was a result of elementary teachers taking a minimal number of science courses at the undergraduate level and virtually no science course work after graduation.[2] Weiss, taking a national survey, found that only 49 percent of the elementary teachers teaching science felt qualified to teach science. This data suggests that 51 percent of the remaining science teachers were somewhere below the "qualified" level.[3] Boulanger concluded in another study that: "the key problem with elementary science education was the general lack of orientation or a background in science by most elementary science teachers."[4]

The curriculum development projects for the elementary and junior high science supported by NSF and OE focused on both teacher preparation activities, and on the construction

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[1]J. G. Horn and R. James, "Where Are We in Elementary Education?" National School Science and Mathematics Association, Des Moines, Nov. 1978. (Mimeographed.)

[2]Jack Gerlovich, G. Downs, and G. Magrane, "How Essential is Science at the Elementary Level?" Science and Children, 19, No. 3 (Nov.-Dec. 1981), 22-24.

[3]Iris Weiss, Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education (Washington, D.C.: National Science Foundation, March 1978), pp. 7-12.

[4]David Boulanger, "Twenty Years of Science Curriculum Reform: A Perspective," Curriculum Review, 19, No. 1 (Feb. 1980), 70-74.

of science materials. By 1968, there were twenty different projects designed specifically for the lower and middle school levels with the majority of the programs being focused on the elementary grades.[1] The materials that were being developed during the 1960's and early 1970's utilized the discovery, inquiry, and problem solving approaches to teaching and learning of science.

Elementary and Junior High Science Programs. The following is a summary of those programs which have appeared to have had a major impact on science education during the 1960's and 1970's:

> Conceptually Oriented Program in Elementary Science (COPES). The central purpose of COPES was to develop vertical continuity in the elementary science curriculum by using conceptual schemes as goals of instruction. The conceptual scheme of science offers a means of relating facts and bits of experience into a meaningful and coherent form. In this way a conceptually-orientated science program builds basic ideas that will be of lasting value to pupils. The basic tenet of this program was to provide learning activities which would involve children intellectually, and lead them personally to the concept. Each activity was designed to provide first-hand experiences through manipulating materials.[2]

> Elementary Science Study (ESS). The ESS program was designed as an exploration of the relationships between man and the physical and biological environment. The entire program consisted of forty instructional units which had no definite sequence.

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[1]Goldberg, pp. 1-2.

[2]COPES: Conceptually Oriented Program in Elementary Science (New York: New York Univ., 1965).

Laboratory activities were designed to provide the student with an experience that would develop process skills. The basic rationale of ESS was to shift the responsibility for learning to the pupil, and stimulate students to devise ways of acquiring and interpreting information.[1]

Science - A Process Approach (SAPA). This program was the first program to present a sequential curriculum for use in elementary schools. The curriculum framework was based on the processes of science. The skills are components of scientific inquiry. SAPA divided these skills into two major groupings: the basic process skills for K-3, and the more complex, integrated skills for 4-6. Each of the process skills were derived from physics, chemistry, biology, earth science, and psychology, and were sequenced through each of the programs. SAPA was designed to provide maximum student involvement with hands-on type activities.[2]

Science Curriculum Improvement Study (SCIS). This program was organized around the conceptual structure of science as it is seen by scientists today. Instruction was designed to take each pupil at his/her present level of development and help him/her to acquire new skills and concepts. The course was sequential, with levels of abstractions building upon each other. The program provides first-hand experiences in a laboratory setting, allowing students to explore natural phenomena individually or in small groups. The principal objective was to develop scientific literacy through understanding science concepts.[3]

Intermediate Science Curriculum Study (ISCS). This was a coordinated science program for use in the junior high school. It was an integrated course

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[1]Paul Hurd and J. J. Gallagher, New Directions in Elementary Science Teaching (Belmont, CA: Wadsworth, 1968), pp. 76-79.

[2]Science - A Process Approach (Washington, D.C.: American Association for the Advancement of Science, 1966).

[3]Robert Karplus and H. D. Thier, A New Look at Elementary School Science (Chicago: Rand McNally, 1967), pp. 35-63.

in the sense that it related science concepts to process skills, and correlated content from the physical and biological sciences. The entire course was divided by grade level (7-9), and was sequential in its design. ISCS was organized so that a conceptual theme and an aspect of scientific inquiry were being taught simultaneously. The material recognized differences in learning styles and allowed for autonomous learners, which in turn allowed the teacher more time to work individually with each student. In addition to normal laboratory activities using problem-solving techniques, ISCS also utilized computer-assisted instruction.[1]

In addition to these programs, courses such as the Elementary School Science Project (ESSP), Elementary-School Science Project (E-SSP), Environmental Studies (ES), Inquiry Development Program (IDP), School Science Curriculum Project (SSCP), Minnesota Mathematics and Science Teaching Project (MinneMAST), Biological Science Curriculum Study (BSCS), Human Science Project (HSP), and others were developed in an attempt to improve the quality of instruction and to promote scientific literacy at both the elementary and junior high levels.[2]

High School Science Education (9-12)

During the past three decades, the high school science program has undergone major changes. Many of the changes have been a direct result of the curriculum reforms; others

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[1] ISCS - Intermediate Science Curriculum Study (Tallahassee: Florida State Univ., 1967).

[2] Hurd and Gallagher, pp. 80-90.

were due to societal influences.

In the early 1950's, during the formative years, NSF began to receive reports from its staff and members of the scientific community that the high school science program was in serious trouble. College teachers were reporting that entering students were inadequately prepared to take college level science courses. In addition, reports indicated that the courses being taught were seriously outdated, and did not reflect the current technological advances.[1]

In 1954, President Eisenhower formed a cabinet level committee to examine the discrepancies in secondary science education, and to examine the reports of the rapidly growing strength in technical training by the Russians. With the full support of the federal government, NSF and the United States Office of Education (USOE) began to rebuild America'a high school science programs.[2]

Following the summer institutes of 1953 and 1954, NSF began to invest heavily into the development of science programs. The programs developed as a result of NSF's involvement included the Biological Science Curriculum Study (BSCS), Individual Science Instruction System (ISIS), and

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[1]U.S., Congress, House, Committee on Science and Technology, The NSF and Pre-College Science Education: 1950-1975, Hearing, 94th Cong., 2nd Sess., Jan. 1975 (Washington, D.C.: GPO, 1976), p. 8.

[2]Ibid., pp. 8-9.

many others which attempted to improve the high school science curriculum.[1]

Physics Education

The physics curricula over the years has evolved in response to growth in information, changing perceptions of the nature of the discipline, and to a variety of other factors involving community and societal needs. The basic topical organization of physics education remained relatively unchanged through the 1950's.[2] The emphasis upon the laboratory of didactic instruction, upon "pure" science and technology, and on facts or conceptual schemes fluctuated periodically. Following World War II, the knowledge and technological advances produced by the war set the stage for dramatic changes in the structure and content of the physics curricula.[3]

The first attempt at providing an up-to-date course in physics was the Physical Science Study Committee (PSSC) program.

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[1] Boulanger, pp. 72-73.

[2] Vincent Lunetta, "Issues in Physics Education in Historical and Contemporary Perspective," Technical Report No. 24 (Iowa City: Science Education Center, Univ. of Iowa, March 1982), pp. 1-3.

[3] Ibid.

Physical Science Study Committee (PSSC). Initial work on the PSSC project began in 1954, and the first publication came in 1960. PSSC was designed as an intensive course focusing on several fundamental concepts of physics. The course was outlined into four major sections, each emphasizing several main concepts.[1] The PSSC curriculum consisted of a student textbook, laboratory guide, films, and a series of supplemental monographs. In addition, PSSC developed an advanced topics course, several physical science courses for the junior high level, and a collegiate edition.[2]

Lunetta indicated that PSSC eliminated almost all relevant applications of physics to daily activities and placed its emphasis on "pure" science. Rather than creating more interest in physics, PSSC alienated a great number of high school students by placing heavy emphasis on mathematics and the highest level of abstraction.[3] In addition, no studies were found which indicated that PSSC provided a higher quality program, nor did studies show that students "learned" physics any better than with the traditional courses.[4]

With an apparent failure of PSSC to fulfill the needs of society, with a new emphasis on teaching the learning disabled and with severe shortages of scientists and engineers being projected, Harvard University began work on

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[1]Physical Science Study Committee, Physics, 2nd ed. (Lexington, VA: D. C. Heath, 1965).

[2]E. P. Little, "The Physical Science Study Committee, Harvard Education Review, 29 (Winter 1959), 2-3.

[3]Lunetta, pp. 4-5.

[4]Dede and Hardin, p. 487.

a new physics program.

> Harvard Project Physics. Initial work on Project Physics, as it is now called, began in 1962. Project Physics was developed to overcome the lack of impact that PSSC had had on physics education. The project developers had three major goals in mind when the project began: (1) design a humanistically oriented course, (2) attract more students to the study of introductory physics, and (3) find out more about the factors that influence the learning of science in schools. The course was intended to increase the appeal of physics by presenting physics as an intellectual pursuit rather than as applied technology. In addition, the course reduced its dependence upon complex mathematical skills, and attempted to reduce perceptions that physics was a difficult course. The project stressed "sound physics," but also emphasized the close connections of physics to other sciences, as well as the historical, social, and cultural consequences related to the progress of science.[1]

Project Physics was introduced to teachers during the summer physics institute of 1967. Rothman conducted a study comparing teachers' attitudes toward physics following the summer institute, and after teaching the Project Physics course for five months. The results of Rothman's study indicated that teachers' attitudes toward physics was somewhat negative after participating in the summer institute. After teaching the program for five months, however, the teachers' attitudes toward physics were much more positive. Rothman concluded that the summer institute had little influence on attitudes, but the actual teaching of the course

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[1]Project Physics, Project Physics Course (New York: Holt, Rinehart and Winston, 1970).

did have a direct impact on teachers' attitudes.[1]

Welch found that, over-all, Project Physics did achieve the three goals set by the developers, but that no data was found to indicate that Project Physics was influential in increasing student-achievement scores when compared to other physics projects.[2]

In addition to PSSC and Project Physics, courses such as the Berkley Physics Course (BPC), Engineering Concepts Curriculum Project (ECCP), and others were developed in an attempt to provide relevant and up-to-date course materials and to improve the instruction of physics education.

Factors Affecting High School Science Education

High school science has experienced several major trends since the early 1960's. The three most significant trends are described below.

Decline in Physics Enrollments. During the past twenty years (1960-1980), high school science courses have experienced a decline of 60 percent participation by high school students in 1960 to 48 percent participation in 1977.[3] The

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[1] Arthor Rothman, "The Effects of Teaching a New Physics Course on Teacher Attitudes," Science Education, 52, No. 5 (Dec. 1968), 468.

[2] Wayne Welsh, "Review of the Research and Evaluation Program of Harvard Project Physics," Journal of Research in Science Teaching, 10, No. 4 (1973), 374-75.

[3] "Education for the 1980's and Beyond," p. 4.

reasons for the decline in enrollments, especially in physics, can be attributed to several factors.

Studies have suggested that declining enrollments in physics are a result of (1) a reduction in science requirements for graduation, and (2) a perception that physics is extremely difficult and is reserved for the intellectuals.[1] Schlessinger reported that at least 50 percent of the students in secondary schools complete their last year of science by the tenth grade.[2] Mahmond supported this data in another study which indicated that tenth grade biology was the most common course taken with enrollments in physics courses being extremely low. The percentage of students taking science in grades ten, eleven and twelve increased from 1955 to 1973, but has shown a decline since 1974. The percentage of students enrolling in physics has shown a slight increase in the late 1960's, but has steadily declined since 1971.[3]

Declining Achievement Scores. In addition to the declines in enrollment, research has indicated a trend in

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[1] Declining Enrollments: The Challenge of the Coming Decade (Washington, D.C.: National Institute of Education, March 1978), pp. 4-5.

[2] F. R. Schlessinger, A Survey of Science Teaching in Public Schools of the United States (1971), Secondary Schools, 1 (Columbus: ERIC Clearninghouse, 1973), pp. 26-29.

[3] Hussein Mahmond, "Secondary School Science Curriculum Practices: A Ten Year Longitudinal Study of Schools in Ten States," Diss. Ohio State Univ., 1981, pp. 15-19.

declining achievement scores during the past twenty years. Harnschfeger and Wiley have reported that since the mid-sixties, achievement scores have declined in grades five through twelve. The most noticeable declines have been in the disciplines of mathematics and general science, with pronounced declines in the physical sciences.[1]

Harms and Kahl have suggested that this decline in achievement scores could be attributed to the fact that much of secondary science education has not considered the needs and interests of the students. This would be especially true for those students who had no intention of pursuing a scientific or technological career.[2] Harms and Yager have indicated that since most technological topics related to societal needs, career choices, and relevant science applications have been ignored by the science programs, a decreased interest in science would result and lower achievement scores would be the result. Additionally, the trends in declining enrollments, achievement test scores, and in graduation requirements have been severely compounded by a generally poor economic picture for the United States.[3]

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[1] A. Harnischfeger and D. Wiley, The Decline of Achievement Test Scores: Evidence, Causes, and Consequences (New Jersey: ERIC Clearinghouse, 1977), p. 1.

[2] Norris Harms and S. Kahl, Project Synthesis Final Report (Boulder: School of Education, Univ. of Colorado, 1980), pp. 5-7.

[3] Harms and Yager, p. 113.

Science Teacher Shortages. The economic problems not only influenced student interests, but also had a marked impact on the production of qualified science teachers. A report by Howe and Gerlovich indicated that since 1970, the number of college students graduating with degrees in science and mathematics, intending to enter the teaching profession, has declined drastically. The study further stated that this trend has been directly affected by, and correlates highly with, the economic status of the United States.[1]

A report by Walsh and Walsh indicated that many public schools are not able to obtain or retain qualified teachers in science and mathematics. The report suggested that many of the qualified teachers presently teaching are being drawn away from the education profession by non-educational institutions.[2]

In 1980, NSF reported that 1,100 mathematics and 400 natural and physical science teaching positions went unfilled in 1977. The report further stated that by 1982 there would be a shortage of 700 natural and physical science teachers throughout the United States.[3]

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[1]T. G. Howe and J. Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1983," CAPSULE, 18, No. 1 (March 1984), 4-6.

[2]E. Walsh and J. Walsh, "Crisis in the Classroom," Science 80, 1, No. 6 (Sept.-Oct. 1980), 17-19.

[3]Science Education Databook, Directorate for Science Education (WAshington, D.C.: National Science Foundation, 1980).

In July of 1980, the American Association of Colleges for Teacher Education (AACTE) reported critical shortages of physics teachers in fourteen states, slight shortages in twenty-three states, and no shortages in only two states.[1] In support of this data, Howe and Gerlovich found adequate numbers of biology and general science teachers, but a critical shortage did exist in physics, as indicated by their data in Appendix C.[2]

Klein reported that between 1971-1980 there was a 77 percent decline in the number of mathematics teachers and a 65 percent decline in the number of science teachers preparing to teach in secondary schools. Klein found that almost five times more science and mathematics teachers left teaching in 1981 for non-teaching positions than did teachers leaving because of retirement. Klein suggested that if this trend continues the United States will have a net loss of 35 percent in its science and mathematics teaching corps by 1992.[3]

The critical shortages in secondary science has forced many school districts either to fill vacancies by giving

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[1]"Do Science Teachers + Math Teachers = Demand?" <u>AACTE Briefs</u>, 1, No. 3 (July 1980), 5.

[2]Howe and Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1983," pp. 5-6.

[3]Klein, pp. 3-5.

additional assignments to current teachers, or by employing unqualified or marginally-qualified teachers on an "emergency basis."[1] Klein suggested that of the newly employed teachers in science hired on an emergency basis, only 50.2 percent were qualified to teach in the scientific disciplines. In addition, Klein suggested that the employment of unqualified or marginally-qualified teachers even on an emergency basis is a major factor in the declining quality of secondary science education.[2]

It has become apparent to most science educators that the long-term shortages in science education must be addressed by stimulating new entrants to teacher-training programs in science, and by developing a system for upgrading and retraining current teachers to teach in related science disciplines.[3]

Status of Science and Science Teaching in Iowa (1970-1983)

Science education in Iowa has been influenced and affected by the trends and problems that have plagued the

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[1] Howard Hausman and A. H. Livermore, A Shortage of Science Teachers by 1982? (Philadelphia: National Science Teachers Association, March 1976), p. 3.

[2] Klein, pp. 8, 16.

[3] Ronald Cohen, "Problem of Retreading Science Teachers, Part 2," Science Education, 56, No. 3 (July-Sept. 1972), 417-21.

science discipline during the past two decades. Research which specifically differentiates Iowa from the remaining states is limited at best. The following sections of this review will focus on the problems and trends in science education as found in Iowa.

Declining Enrollments

The trends in Iowa's public schools indicate that enrollments since 1973 for grades K-12 have declined by 130,116 students. The projected enrollment figures, according to Howe and Gerlovich, are expected to decline by another 31,444 students within the next five years.[1]

The over-all decline in school enrollments has also influenced the number of students enrolling in science courses at the high school level (9-12). From 1970 to 1977, enrollments in physics, chemistry, and mathematics declined steadily, but in 1978, the enrollments began to increase slightly.[2]

Table 1 indicates that between 1978 and 1984, the total number of students enrolled in physics and chemistry increased by 1,346 students.[3] According to Gerlovich, this

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[1] T. Howe and J. Gerlovich, "Crisis in Science Education: Problems and Recommendations," Iowa Science Teachers Journal, 20, No. 2 (Autumn 1983), 2-3.

[2] Personal interview with Jack Gerlovich, 29 March 1984.

[3] Jack Gerlovich, "Are We Buying Our Students?" (Des Moines: Department of Public Instruction, Feb. 1984), p. 3. (Mimeographed.)

represents the highest level of student enrollment in these disciplines since 1977, and it is even more meaningful when viewed within the context of a total high school enrollment decline of 42,000 students since 1977.[1]

Table 1

Number of Pupils Enrolled in Physics and Chemistry in Iowa Public Schools 1978-1984

	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84
Physics	6,236	6,509	7,033	6,806	6,912	7,357
Chemistry	15,053	14,802	14,615	14,693	14,818	16,278
Total Physics and Chemistry Enrollments (9-12)	21,289	21,311	21,648	21,499	21,730	23,635
Percentage of Students Enrolled in Physics and Chemistry	11.0%	11.5%	12.2%	12.7%	13.5%	15.2%
Total Public School Enrollments (9-12)	193,204	185,093	177,195	168,720	160,028	155,217

Table 1 also indicates that the largest enrollment increase in physics and chemistry occurred during the 1983-84 school year. One possible cause for this phenomenon could be due to the passing of Iowa bill H.F. 532. H.F. 532 contained the following components:

[1]Gerlovich, "Are We Buying Our Students?" p. 2.

- High school students who graduate from high schools after January 1, 1984, and complete 7 units of mathematics and science courses (3 of which must be in advanced mathematics, physics or chemistry), they could qualify for up to $500 toward tuition at an Iowa college.

- For teachers who graduate from college after January 1, 1983, with a major in mathematics or science and who has an Iowa guaranteed loan to repay, the state would help repay $6,000 of these loans if that individual taught chemistry, physics or advanced mathematics in an approved Iowa public or private school.

- For those individuals currently teaching who would like to teach advanced mathematics or science, the state would help pay tuition for advanced training at the rate of $1,000-$1,500 per year.

- For high schools (grades 9-12) who enroll students in first year foreign language courses, they would receive $50 for each individual enrolled; and $25 for each student enrolled in advanced mathematics, physics, or chemistry courses.[1]

It would appear that since the introduction of H.F. 532 and the increased enrollments in physics and chemistry occurring simultaneously that a correlation between the two could exist. No research to date, however, suggests that such a relationship has occurred.[2]

Declining Achievement Scores

The achievement test scores within the discipline of

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[1] 1983 Interim Supplement to the 1983 Code, Sections 1-15 (Des Moines: Iowa Legislative Bureau, State of Iowa, 1984).

[2] Gerlovich, "Are We Buying Our Students?" p. 2.

physics has also been affected by national trends. As a means of measuring the academic achievement of Iowa's high school students, Iowa has utilized the Iowa Test of Educational Development (ITED) for grades nine through twelve. In a study conducted by Gerlovich, significant fluctuations in science achievement scores have occurred between 1962 and 1977. These achievement scores apparently peaked during the mid-sixties and have shown a steady decline.[1]

Gerlovich attributes a portion of this decline to two factors: (1) to the minimal emphasis placed on science education after the "golden decade" of 1960-1970, which placed a high emphasis on science education, and (2) the introduction of elective courses to the high school curriculum beyond the tenth grade.[2]

Science Teacher Shortages

There are twenty-seven institutions in Iowa that have approved teacher education programs. These four-year colleges or universities recommend graduates for certification to the Department of Public Instruction (DPI). Bachelor degree graduates who have completed the preparation for a teaching certificate have been the primary source of new

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[1] Jack Gerlovich, "Some National Trends in High School Science Education and Their Influence in Iowa," Iowa Science Teachers Journal, 16, No. 1 (April 1979), 40.

[2] Ibid., p. 41.

teachers in Iowa, accounting for 82 percent of the teacher candidates.[1]

A summary of bachelor degree graduates prepared in Iowa for all science disciplines is described in Appendix D. This appendix indicates that in 1970 there were 269 science teacher graduates from the twenty-seven institutions, but by 1982 the total number of graduates had declined to only eighty-seven.[2] In addition, Howe and Gerlovich had indicated that in 1982 there were ninety-seven vacancies opened for science teachers in Iowa, which would indicate that a shortage did exist. More specifically, their study suggests that critical shortages exist in earth science, physical science, chemistry, and physics.[3]

One of the factors leading to this shortage in Iowa, according to Howe and Gerlovich, is the competition from business and industry for the service of people with specific science skills.[4] Since 1977, the salaries paid by industry were approximately 50 to 75 percent higher than those for teaching on an annual basis. This problem is further compounded by the fact that schools are experiencing

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[1] T. G. Howe and J. Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1982," CAPSULE, 16, No. 4 (Nov. 1982), 4.

[2] Ibid., p. 9.

[3] Ibid., p. 10.

[4] Ibid., p. 11.

declining enrollments and staff reductions.[1]

The solution(s) to this shortage problem will not be found easily. Gerlovich and Unruh have indicated that retraining teachers to teach physics or any critical content subject through traditional academic programs does not appear to be a viable option. Because the travel and subsistence costs have risen, funded sabbaticals are impractical, and most teachers are involved with extracurricular activities making college attendance very difficult during the summer months.[2] Howe and Gerlovich conclude:

> Long range consequences of continued critical shortages on the total education system can be extremely serious. Many math and science courses are being taught by less qualified teachers.... this threatens the quality of instruction....many schools will be forced to drop some mathematics and science offerings because of staff shortages.[3]

In response, the Iowa Department of Public Instruction (DPI) has initiated steps to alleviate the science teacher shortage in Iowa, and more specifically to alleviate the critical shortage existing in physics.

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[1]Howe and Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1982," p. 9.

[2]Gerlovich and Unruh, pp. 5-6.

[3]Howe and Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-82," p. 11.

The Development of the Physics Resources and Instructional Strategies for Motivating Students (PRISMS) Program

In the fall of 1977, the DPI began to receive an inordinate number of requests from science coordinators and science teachers for assistance in assessing and revising outdated science curriculums.[1] By late 1979, the DPI had developed and pilot tested a guide to assist science teachers in assessing their science curriculum. A Tool for Assessing and Revising the Science Curriculum[2] proved very effective as a means of evaluating science curricular strengths and needs. Serious problems developed, however, when attempting to satisfy the needs through existing published materials, and the physics materials presented some intractable problems.[3]

By 1981, the teacher shortages and curricular problems in the sciences had been communicated to the education committee of the Iowa legislature. In October of 1981, the DPI created a task force, as requested by then Governor Robert D. Ray, to address the teacher shortage and curricular

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[1]Jack Gerlovich, G. Downs, and G. Magrane, "Assessing, Implementing, and Evaluating Science Curriculum (K-12) for Iowa Schools," Iowa Science Teachers Journal, 17, No. 2 (Sept. 1981), 5-7.

[2]Jack Gerlovich and others, A Tool for Assessing and Revising the Science Curriculum (Des Moines: Department of Public Instruction, 1979).

[3]Gerlovich and Unruh, p. 4.

problems unique to physics. The following criteria were delineated for this task force:

- Upgrade teachers who are weak in science content areas.

- Provide curricular materials based upon practical application activities. These activities must require simple and inexpensive laboratory equipment, and should not require more than one year of algebra.

- It must also include computer applications.

- It must be provided through a cost effective delivery system.[1]

In June, 1982, the state science consultant, Dr. Jack Gerlovich, was contacted by the Governor's Science Advisory Council (GSAC) and the Iowa Academy of Science (IAS) to study the science teacher supply-and-demand inconsistencies, problems resulting from such inconsistencies, and propose solutions to these problems.[2]

In the fall of 1982, the Ad Hoc Education Committee began to assess the state science problems. Among the major recommendations that the committee suggested to Governor Ray were the following:

- Salaries of teachers in short supply must be made competitive with those in the private sector.

- Preservice scholarship and loan forgiveness programs must be initiated for science teachers.

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[1]Gerlovich and Unruh, pp. 4-5.

[2]Personal interview with Jack Gerlovich, 8 Feb. 1984.

- Cost effective, continuous inservice programs for upgrading current science teachers should be initiated.

- Prospective science teachers should complete coursework for the DPI "all sciences" approval to improve their employability.

- Local schools should require 2 years (units) of science (1 biological and 1 physical science) for graduation.[1]

As a result of this study, the DPI committed $6,500 toward studying solutions to the plight of physics education in Iowa for the academic year 1982-83. The physics task force began developing several units in physics which focused upon student application of physics content to contemporary problems. The initial curriculum materials were pilot-tested in AEA 15 in Southeast Iowa.[2]

One major problem that the trial emphasized was the need for a cost effective delivery system. Through cooperation with Drake University, and the College of Pharmacy, the task force was advised of a telephone system that the College of Pharmacy used to retrain pharmacists. On January 17, 1983, the physics task force initiated regular telephone programs to the pilot schools in Southeast Iowa.[3]

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[1]Gerlovich and Unruh, p. 5.

[2]Personal interview with Jack Gerlovich, 20 April 1984.

[3]Personal interview with Roy Unruh, physics professor, Univ. of Northern Iowa, Cedar Falls, Iowa, 2 June 1983.

During the summer of 1983, the physics task force met at the University of Northern Iowa to refine the existing physics units, and to develop new units reflecting current technological advances. In addition, the task force implemented a telecommunications delivery system utilizing the Iowa Regent's Telebridge network.[1] This process requires that each classroom be fitted with a telephone set and a speaker-phone unit. This process would allow interactive participation between the teachers and the university professor.

The Iowa legislature allocated an additional $40,000 to the DPI for the physics project during the summer of 1983. This additional financial support enabled the task force to acquire additional computer software, telephones, and speaker-phones for the high schools participating in the pilot program.[2] In addition to the state allocation, the Office of Education awarded a grant of $132,000 for development expansion, and evaluation of the Physics Resources and Instructional Strategies for Motivating Students (PRISMS) program.[3]

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[1]Personal interview with Roy Unruh, 2 June 1983.

[2]Personal interview with Roy Unruh, 2 June 1983.

[3]Personal interview with Jack Gerlovich, 9 Jan. 1984.

The PRISMS Program

The physics task force decided to develop a teacher's guide which would give guidance to those teachers with limited background experience in physics.

The teaching strategies in PRISMS are based on a learning theory derived from Piaget's work associated with formal reasoning skills. In addition, the PRISMS materials have incorporated the "learning cycle" as described by Karplus.[1]

According to Karplus, the learning cycle includes three phases, (1) exploration, (2) concept introduction, and (3) concept application.[2] Karplus contends that during the exploration phase, students will interact with materials and ideas related to a given phenomena with little or no direction from the teacher. The concept introduction phase would involve developing a specific concept, through utilization of textbooks, around the activities which occurred during the exploration phase. For example, if the exploration phase activities involved toy cars, the concept introduction phase could focus on motion, acceleration, or time as concept to be developed during the concept

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[1]Jack Gerlovich, "The Iowa Physics Project" (Des Moines: Department of Public Instruction, Feb. 1984), pp. 1-2. (Mimeographed.)

[2]Robert Karplus and others, Science Teaching and the Development of Reasoning--Physics (Berkeley: Lawrence Hall of Science, Univ. of California, 1977).

introduction phase.[1]

The third phase, concept application, would take this newly acquired information about a concept and attempt to apply it to other situations within the student's environment. This phase could also involve additional activities which would reinforce what learning had taken place, and also to show the interrelationship of scientific concepts in a variety of situations.[2]

The various phases of the learning cycle can be initiated by using a diversity of media forms. PRISMS has incorporated computer programs, electronic devices, and video tapes into the physics program. These forms of media were utilized to simulate activities, in part, that would be cost prohibitive for many individual schools to conduct. In addition, the teacher is provided with activities and ways to develop reasoning skills, present physics concepts, and apply these concepts to a variety of situations.[3]

The physics task force did not intend for the PRISMS materials to replace the existing textbooks currently in use. The materials, however, are intended as a resource which will provide structure and organization to the study

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[1]Personal interview with Roy Unruh, Storm Lake, Iowa, 30 Aug. 1983.

[2]Karplus and others.

[3]Gerlovich, The Iowa Physics Project, p. 3.

of physics, and incorporates modern technological advances to physics with applications to practical issues facing high school students.[1]

During the past two decades enormous advances in physical, biological, and technological sciences have been made. If educational systems are to fulfill the goals of science, as described by Nelson and Dietrich, by developing scientifically literate individuals, then these advances must be interwoven into science programs, and presented through practical and meaningful experiences.[2] Science must become both functional and relevant to the general public, but also be challenging for those individuals seeking deeper enrichment.

Summary

The research reviewed in this chapter has indicated that a critical teacher shortage does exist in Iowa, and throughout the United States in physics education. The need for a cost effective program to retrain current science teachers has been identified. In response, the Physics Resources and Instructional Strategies for Motivating Students (PRISMS) program was developed as a means of

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[1]Gerlovich, The Iowa Physics Project, p. 3.

[2]Miles Nelson and D. G. Dietrich, "Declining Physics Enrollments--An Exploration of Reasons," School Science and Mathematics, 75, No. 7 (Nov. 1975), 606-14.

alleviating the physics teacher shortage in Iowa. Chapter Three will present the methodology of this study.

CHAPTER THREE

Methodology of the Study

The problem of this study was to determine if the PRISMS program influences the teachers' knowledge of physics concepts. In this chapter the assumption, methods, and procedures for treating the data will be presented.

Assumption

The sensitivity of the issue and the type of questioning did not cause the teachers or administrators to respond dishonestly.

Limitations of the Study

The results and conclusions of this study were limited to the twenty-nine teachers and twenty-nine administrators selected for participation by their individual Area Education Association (AEA) science consultants. Because the participants were selected by the AEA consultants and not drawn randomly from a larger population, caution should be used in any generalization beyond the sample.

Methods

Selection of Participants

The subjects for this research study were selected by his/her AEA science consultant from criteria developed by the state science consultant.[1] The criteria statements were:

1. Provide a micro-computer to the teacher when needed.
2. Provide a video tape recorder to the teacher when needed.
3. Attempt to increase physics enrollments through improved teaching.
4. Send both administrator and teacher to inservice programs designed to familiarize each participant with the PRISMS program.
5. Pilot-test the process laboratory activities.
6. Provide feedback to the physics task force on the program's effectiveness
7. Provide a brief description of the teachers' need in relation to being a part of the PRISMS program.

Each AEA science consultant selected three high schools within his/her area. Fifty-two schools were accepted into the program from various locations throughout Iowa. Data analysis for this study required matched responses from teachers and accompanying principals from the fifty-two schools. As a result, only twenty-nine complete matched sets were available for analysis. Permission was granted by the state science consultant to conduct this study in conjunction with the physics task force.

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[1]Personal interview with Jack Gerlovich, 3 Oct. 1983.

Data Collection Instruments

The data collection instruments, designed specifically for this study, consisted of pre-questionnaires and post-questionnaires, and a pre-assessment and post-assessment form (see Appendices E, F and G).

Teachers' Questionnaire. The teachers' questionnaire was designed to elicit teachers' attitudes toward the PRISMS program, and their level of comfort with presenting physics concepts. The teachers' questionnaire was divided into two separate sections. Section I, containing Items 1 through 17, reflect the teachers' level of comfort. Section II, Items 18 through 29, reflects both the attitudes and opinions toward the PRISMS program.

The content from this questionnaire was derived from the objectives set by the physics task force, and as such, was considered content valid. The questionnaire was approved by the task force after several alterations.

Administrators' Questionnaire. The administrators' questionnaire was designed to elicit their attitudes and opinions toward the PRISMS program. The content of this questionnaire was derived from the objectives set by the physics task force, and as such, was considered content valid. The questionnaire was approved by the task force after several alterations.

Teachers' Assessment Form. The teachers' assessment form was designed to measure the teachers' knowledge of physics content. The items on this form were drawn directly from the program's objectives, and as such, are considered content valid.

Test for Reliability and Program Administration

The reliability test for the assessment form was conducted by utilizing a representative group of six teachers in Iowa. The teachers were selected for their proximity, accessibility, and availability to the researcher. A coefficient of stability for reliability was determined through the utilization of the "test-retest" process. The tests were given one week apart. Pearson Product-moment correlation was applied, and a coefficient of .79 was found. This coefficient was considered acceptable.

The pre-program collection instruments were administered by the researcher during inservice programs held by the DPI at five AEA locations in Iowa (see Appendix I). The teachers and administrators were separated in different rooms while the instruments were being administered. Thus, the testing environment was controlled, allowing for no discussion until each instrument had been returned to the researcher. This was done to insure independence in the answering.

The teachers' post-program collection instruments were administered by the researcher during an inservice program held at Heartland AEA in Ankeny, Iowa. The testing environment was controlled insuring independence in the answering.

The administrators were not in attendance during this second inservice program, and the post-questionnaire forms were mailed to each participating administrator.

Procedures for Treating Data

The data derived from this study were descriptive in nature. The design of the questionnaire and assessment instruments required several different types of statistical analyses. The paired t-test, Pearson's r, and descriptive statistics were applied in an attempt to answer the questions of this study. The significance levels chosen were .05 (significant) and .01 (highly significant).

The paired t-test was used to examine the changes in scores for the administrators' attitudes, teachers' attitudes and comfort, and the teachers' level of knowledge. The t-test was applied to Hypotheses 3, 4, 5, and 6 as stated in Chapter One. Pearson's r was calculated for the remaining hypotheses to determine if relationships between continuous dependent variables were occurring.

In an attempt to determine changes in teachers' and administrators' opinions, descriptive statistics were applied to Items 18, 27, 28, and 29 of the teachers' questionnaire, and Items 2, 6, 9, 10, 13, and 14 of the administrators' questionnaire.

Summary

In this chapter the assumption, methods and procedures for treating the data were presented. Chapter Four will present the data derived from this study, and Chapter Five will give the conclusions, discussion, and further recommendations.

CHAPTER FOUR

Presentation of Data

Introduction

The purpose of this study was to see if PRISMS could contribute to the improvement of physics instruction through improved teaching strategies and by improving the teachers' knowledge of physics. This chapter will present the correlations between major study variables, mean differences, and descriptive statistics for selected items.

Findings and Analysis

Table 2 describes the correlations between major variables for fifteen null hypotheses. The data indicates low to moderate correlations for eleven of the fifteen null hypotheses tested. These correlations were not significant at the .05 or .01 levels, and thus failed to reject null Hypotheses 1, 2, 7, 8, 10, 12, 14, 15, 17, 18, or 19. A complete listing of the correlation coefficients can be seen in Appendix J.

The data in Table 2 does indicate, however, a negative correlation between the administrator and teacher attitude gain scores. Since this correlation existed, null Hypothesis 9 was rejected. The data indicated that teachers' gain

Table 2

Pearson Product-Moment Correlation for Relationships Between Major Study Variables (N=29)

Hypotheses	r
1. There is no relationship between the number of years teaching physics and the level of comfort in presenting physics concepts after program implementation.	.11
2. There is no relationship between the teachers' attitudes toward teaching physics and the level of comfort in presenting concepts related to physics after program implementation.	.19
7. There is no relationship between the teachers' level of knowledge of physics and the level of comfort after program implementation.	.05
8. There is no relationship between the teachers' attitudes toward physics and the level of knowledge of physics concepts after program implementation.	.20
9. There is no relationship between administrator and teacher attitude gain scores resulting from program implementation.	.50**
10. There is no relationship between the administrators' post-program attitudes and the teachers' post-program level of comfort in presenting physics concepts.	.16
11. There is no relationship between the administrators' pre-program attitudes and the teachers' gain in knowledge level of physics concepts.	.38*
12. There is no relationship between the teachers' number of years teaching physics and teachers' attitudes toward teaching physics after program implementation.	.03
13. There is no relationship between the number of years teaching physics and the teachers' gain in knowledge level of physics concepts.	.40*

Table 2 (continued)

Hypotheses	r
14. There is no relationship between the teachers' years in teaching physics and the administrators' attitudes toward this program before program implementation.	.17
15. There is no relationship between the teachers' hours of college physics and the teachers' attitudes toward this program before program implementation.	.26
16. There is no relationship between the teachers' hours of college physics and the teachers' level of comfort in presenting physics concepts before program implementation.	.42*
17. There is no relationship between the teachers' hours of college physics and the teachers' level of comfort presenting physics concepts after program implementation.	.29
18. There is no relationship between the teachers' hours of college physics and the teachers' level of knowledge of physics concepts after program implementation.	.25
19. There is no relationship between the teachers' hours of college physics and the administrators' attitudes toward this program before program implementation.	.19

$*p<.05$
$**p<.01$

scores and administrators' attitudes change concurrently. The data revealed a decrease in attitude gain scores for teachers and administrators.

The data in Table 2 indicated that a positive correlation between the administrators' pre-program attitudes and teachers' knowledge gain existed. Therefore, null Hypothesis 11 was rejected. These data indicated that the more positive the pre-program attitudes of the administrators, the greater the knowledge gains of teachers as a result of participating in the PRISMS program.

Null Hypothesis 13 was also rejected. The data indicated that a relationship between the number of years teaching physics and the teachers' gain in knowledge existed. The data showed that the more years of teaching physics, the greater the knowledge gain in physics concepts.

Finally, a correlation was found between teachers' hours of college physics and their level of comfort. As a result of this relationship, null Hypothesis 16 was rejected. The data indicated that the more hours of college physics, the more comfortable the teachers were at presenting physics concepts.

Table 3 reveals the data from the paired-t tests. The tests were applied to determine if differences existed between the administrators' and teachers' attitudes, teachers' knowledge level, and teachers' comfort before and after program implementation. The data from Table 3 indicated no or minimal differences in the administrators' attitudes toward the PRISMS program, and as such, null Hypothesis 3 was not rejected.

Table 3

Paired-t Tests for Differences in Administrators' and Teachers' Attitudes, Teachers' Knowledge, and Comfort Before and After Program Implementation

Hypotheses	Paired-t*
3. There is no difference in the administrators' attitudes toward utilizing this training program as a result of program implementation.	.73
4. There is no difference in the teachers' attitudes toward teaching physics before and after program implementation.	4.64**
5. There is no difference in the teachers' level of knowledge of physics following program implementation.	2.37*
6. There is no difference in the teachers' level of comfort with presenting physics concepts before and after program implementation.	2.65*

*$p < .05$
**$p < .01$

As a result of the study, Hypothesis 4 was rejected. The data indicated that teachers had fewer positive attitudes toward teaching physics as a result of participating in the PRISMS program.

Null Hypothesis 5 was rejected. The data indicated that the teachers experienced a gain in their knowledge level as a result of participating in the PRISMS program.

Finally, null Hypothesis 6 was rejected. The data in Table 3 indicated that teachers experienced an increase in their level of comfort in presenting physics concepts as a result of participating in the PRISMS program.

Table 4 reveals the mean pre- and post-test opinion scores for the teachers on selected items from the questionnaire. The data in Table 4 indicated that a moderate decrease in teachers' opinions occurred in Items 18, 27, and 28. The data from this table also indicated an increase in teachers' opinion for Item 29.

Table 4

Mean Pre and Post Teacher Opinion Scores for Selected Items (N=29)*

Items		Pre	Post
18.	Laboratory activities should be an important part of the physics program.	5.58	5.44
27.	Computers would be an effective teaching aid for this physics program.	5.41	4.79
28.	This program will increase the number of students enrolling in physics.	4.58	4.17
29.	This particular program will require more preparation time.	4.86	5.17

*Scale: 1 = Strongly Disagree to 6 = Strongly Agree

Table 5 reveals the mean pre- and post-test opinion scores for the administrators on selected items from the questionnaire. The data in Table 5 indicated that a moderate decrease in opinions occurred for Items 2, 6, 10, and 14. In addition, Table 5 also indicated a moderate increase in opinion scores by the administrators for Items 9 and 13.

Table 5

Mean Pre and Post Administrator Opinion Scores for Selected Items (N=29)*

Items		Pre	Post
2.	Laboratory activities should be an important part of a physics program.	5.62	5.27
6.	My teacher has expressed a confident attitude toward being a part of this program.	5.44	5.17
9.	My teacher does have the skills and abilities required when utilizing the laboratory equipment.	5.00	5.37
10.	Computers would be an effective teaching aid for this physics program.	5.20	4.82
13.	This type of program will require more teacher preparation time.	4.27	4.69
14.	This type of program may cause the school district to provide more financial support for physics instruction.	3.86	3.37

*Scale: 1 = Strongly Disagree to 6 = Strongly Agree

Summary

This chapter presented the data for this research study. The data indicated that teachers' attitudes toward teaching physics and toward the PRISMS program decreased.

In addition, the teachers experienced an increase in their knowledge of physics content, and became more comfortable with presenting physics concepts as a result of the PRISMS program. Finally, the data indicated that the administrators' attitudes toward the PRISMS program decreased, and that both teachers' and administrators' experienced a general decrease in opinion scores for selected items from the questionnaires.

CHAPTER FIVE

Summary, Conclusions, Discussion, and Recommendations

Summary of the Investigation

The purpose of this study was to see if PRISMS could contribute to the improvement of physics instruction in the state of Iowa. Since the PRISMS program was experimental in nature and represented a new concept in teacher preparation, no base line data existed which reported on the effectiveness of such a program. While PRISMS had a twofold purpose of improving teaching strategies in physics and students' attitudes toward physics, the problem of this study was to determine if PRISMS influenced the teachers' knowledge of physics content.

The participants of this study were selected by their AEA science consultants. The data required matched responses from teachers and administrators; consequently, only twenty-nine were available for analysis. The paired-t test, Pearson's r, and descriptive statistics were applied to the data. The significance levels were .01 and .05.

The data for this study were collected through pre-questionnaires and post-questionnaires for teachers and administrators. In addition, a pre-assessment and post-assessment physics knowledge instrument was applied to the teachers. The questionnaires were designed to elicit teachers' and administrators' attitudes and opinions. The assessment form measured the teachers' knowledge of physics. The data were collected at two inservice programs conducted by the DPI.

The findings from this research are limited to the twenty-nine teachers and twenty-nine administrators selected for participation in the PRISMS program. Because the participants were not drawn from a random sample, caution should be used in any generalization beyond the sample.

Summary of the Findings

The results of the research, which were obtained by analyzing the data presented in four tables and by testing the null hypotheses, prompted the following summaries:

1. As a result of program participation, the teachers' attitudes toward teaching physics decreased from more positive attitudes to somewhat negative attitudes.

2. As a result of program participation, the teachers' level of comfort with presenting physics concepts increased.

3. As a result of program participation, the teachers experienced an increase in their knowledge of physics content.

4. As a result of the PRISMS program, the attitudes gain scores decreased concurrently for teachers and administrators.

5. The administrators' pre-program attitudes influenced the teachers' level of knowledge.

6. The teachers' level of knowledge was influenced by the years of experience in teaching physics.

7. The teachers' level of comfort was influenced by the number of hours taken in college physics before the PRISMS program.

In addition, the descriptive statistics indicated a general decrease in the teachers' and administrators' opinions for most of the statements selected from the questionnaires. The data also indicated that the teachers and administrators agreed that the PRISMS program required much preparation time.

Conclusion

On the basis of the findings from this study the following conclusion was reached:

The study results were not sufficient to indicate that the PRISMS program improved physics instruction in Iowa.

Discussion of the Findings

Identifying the causes for the changes in attitudes is beyond the scope of this study. However, one might infer from the results the following:

The decrease in teachers' attitudes and opinions may be attributed to several factors. First, the final inservice program may have been held too late in the school year. Historically, end-of-year high school activities place additional burdens on teachers, especially on those teachers already holding several teaching responsibilities.

Second, the final inservice meeting location necessitated long distance travel affecting a majority of the teachers from rural Iowa.

Third, other causes for the declines could be due to external factors; i.e., poor local telephone connections, computer and equipment failures, and administrative pressures required by PRISMS.

The decrease in administrators' attitudes and opinions may be due, in part, to end-of-year activities and added responsibilities. In addition, the difference between the testing environments for the administrators may have influenced their responses.

Recommendations

On the basis of the findings from this study, it is recommended that:

1. An investigation should be conducted to determine what effect the PRISMS program might have on future student learning.

2. An in-depth investigation should be conducted to compare student achievement scores for districts using PRISMS with similar districts not using PRISMS.

3. An investigation should be conducted to determine why the teachers' attitudes decreased while participating in the PRISMS program.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Bloom, B. S. Taxonomy of Educational Objectives, the Classification of Educational Goals. New York: David McKay, 1964.

Bruner, Jerome. The Process of Education. New York: Vintage Books, 1960.

COPES: Conceptually Oriented Program in Elementary Science. New York: New York Univ., 1965.

Goldberg, Lazer. Children and Science. New York: Charles Scribner's Sons, 1970.

Hurd, Paul, and J. J. Gallagher. New Directions in Elementary Science Teaching. Belmont, CA: Wadsworth, 1968.

ISCS - Intermediate Science Curriculum Study. Tallahassee: Florida State Univ., 1967.

Karplus, Robert, and H. D. Thier. A New Look at Elementary School Science. Chicago: Rand McNally, 1967.

Karplus, Robert, and others. Science Teaching and the Development of Reasoning--Physics. Berkeley: Lawrence Hall of Science, Univ. of California, 1977.

Physical Science Study Committee. Physics. 2nd ed. Lexington, VA: D. C. Heath, 1965.

Piaget, Jean. Science of Education and the Psychology of the Child. New York: Orion Press, 1970.

Project Physics. Project Physics Course. New York: Holt, Rinehart and Winston, 1970.

Science - A Process Approach. Washington, D.C.: American Association for the Advancement of Science, 1966.

Periodicals

Ayers, J. B., and M. N. Ayers. "Influence of SAPA on Kindergarten Children's Use of Logic in Problem Solving." School Science and Mathematics, 73 (Dec. 1973), 768-71.

Boulanger, David. "Twenty Years of Science Curriculum Reform: A Perspective." Curriculum Review, 19, No. 1 (Feb. 1980), 70-74.

Bruner, Jerome. "The Act of Discovery." Harvard Education Review, 30, No. 1 (Winter 1961), 21-32.

Bybee, Rodger. "The New Transformation of Science Education." Science Education, 61, No. 1 (Jan.-March 1977), 85-97.

________, and others. "Science, Society, and Science Education." Science Education, 64, No. 3 (July 1980), 377-95.

Cohen, Ronald. "Problems of Retreading Science Teachers, Part 2." Science Education, 56, No. 3 (July-Sept. 1972), 417-21.

Dede, Christopher, and Joy Hardin. "Reforms, Revisions, Re-examinations: Secondary Science Education Since World War II." Science Education, 57, No. 4 (Oct.-Dec. 1973), 485-91.

"Do Science Teachers + Math Teachers = Demand?" AACTE Briefs, 1, No. 3 (July 1980), 1-5.

Gerlovich, Jack. "Some National Trends in High School Science Education and Their Influence in Iowa." Iowa Science Teachers Journal, 16, No. 1 (April 1979), 37-43.

________, G. Downs, and G. Magrane. "Assessing, Implementing, and Evaluating Science Curriculum (K-12) for Iowa Schools." Iowa Science Teachers Journal, 17, No. 2 (Sept. 1981), 5-9.

________. "How Essential is Science at the Elementary Level?" Science and Children, 19, No. 3 (Nov.-Dec. 1981), 22-24.

Howe, T., and J. Gerlovich. "Crisis in Science Education: Problems and Recommendations." Iowa Science Teachers Journal, 20, No. 2 (Autumn 1983), 2-4.

________. "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1982." CAPSULE, 16, No. 4 (Nov. 1982), 4-6.

________. "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers: 1980-1983." CAPSULE, 18, No. 1 (March 1984), 4-6.

Little, E. P. "The Physical Science Study Committee." Harvard Education Review, 29 (Winter 1959), 2-3.

Nelson, Miles, and D. G. Dietrich. "Declining Physics Enrollments--An Exploration of Reasons." School Science and Mathematics, 75, No. 7 (Nov. 1975), 606-14.

Rothman, Arthor. "The Effects of Teaching a New Physics Course on Teacher Attitudes." Science Education, 52, No. 5 (Dec. 1968), 466-69.

Walsh, E., and J. Walsh. "Crisis in the Classroom." Science 80, 1, No. 6 (Sept.-Oct. 1980), 17-19.

Welsh, Wayne. "Review of the Research and Evaluation Program of Harvard Project Physics." Journal of Research in Science Teaching, 10, No. 4 (1973), 365-78.

Dissertations

Audeh, R. Ghazi. "A Longitudinal Study of Science Curriculum and Practices in Elementary Schools in 10 States (1970-1980)." Diss. Ohio State Univ., 1982.

Mahmond, Hussein. "Secondary School Science Curriculum Practices: A Ten Year Longitudinal Study of Schools in Ten States." Diss. Ohio State Univ., 1981.

Other Sources

Declining Enrollments: The Challenge of the Coming Decade. Washington, D.C.: National Institute of Education, March 1978.

"Education for the 1980's and Beyond." Science and Engineering. Washington, D.C.: National Science Foundation and Office of Education, Oct. 1980.

Gerlovich, Jack. "Are We Buying Our Students?" Des Moines: Department of Public Instruction, Feb. 1984. (Mimeographed.)

________. "The Iowa Physics Project." Des Moines: Department of Public Instruction, Feb. 1984. (Mimeographed.)

Gerlovich, Jack, and others. A Tool for Assessing and Revising the Science Curriculum. Des Moines: Department of Public Instruction, 1979.

________. "The Crisis in Science and Mathematics Education in Iowa: The Problem and Recommendations." Des Moines: Governor's Science Advisory Council and the Iowa Academy of Science, Oct. 1982. (Mimeographed.)

Gerlovich, Jack, and Roy Unruh. "Upgrading Physics Teachers and Curriculum Through Application of Technology." Des Moines: Department of Public Instruction, 1983. (Mimeographed.)

________, and others. Physics Resources and Instructional Strategies for Motivating Students. Des Moines: Iowa Department of Public Instruction, Aug. 1983.

Greenleaf, Warren, and G. A. Griffin. Schools for the 70's and Beyond: A Call to Action. Washington, D.C.: National Education Association, Feb. 1971.

Harms, Norris, and R. Yager. What Research Says to the Teacher, 3. Washington, D.C.: National Science Teachers Association, 1981.

Harms, Norris, and S. Kahl. Project Synthesis Final Report. Boulder: School of Education, Univ. of Colorado, 1980.

Harnischfeger, A., and D. Wiley. The Decline of Achievement Test Scores: Evidence, Causes, and Consequences. New Jersey: ERIC Clearninghouse, 1977.

Hausman, Howard, and A. H. Livermore. A Shortage of Science Teachers by 1982? Philadelphia: National Science Teachers Association, March 1976.

Helgeson, Stanley, P. E. Blosser, and R. W. Howe. "The Status of Pre-College Science, Mathematics, and Social Studies Education: 1955-1975." Science Education Information Reports. Columbus: ERIC Clearinghouse, 1977.

Horn, J. G., and R. James. "Where Are We in Elementary Education?" National School Science and Mathematics Association, Des Moines, Nov. 1978. (Mimeographed.)

Klein, Sarah. Testimony to Committee on Labor and Human Resources of the United States Senate in Regard to 1983 Authorization for the Science Education Component of the National Science Foundation. Washington, D.C.: National Science Teachers Association, April 1982.

Lunetta, Vincent. "Issues in Physics Education in Historical and Contemporary Perspective." Technical Report No. 24. Iowa City: Science Education Center, Univ. of Iowa, March 1982.

Minutes from Ad Hoc Education Committee. Des Moines: Department of Public Instruction, 21 Sept. 1982.

National Science Foundation - Supported Science Education Materials: Problems in Evaluation, Distribution, and Monitoring. Washington, D.C.: GPO, 1976.

1983 Interim Supplement to the 1983 Code. Sections 1-15. Des Moines: Iowa Legislative Bureau, State of Iowa, 1984.

Schlessinger, F. R. A Survey of Science Teaching in Public Schools of the United States (1971), Secondary Schools, 1. Columbus: ERIC Clearinghouse, 1973.

Science Education Databook. Directorate for Science Education. Washington, D.C.: National Science Foundation, 1980.

Science and Mathematics in the Schools: Report of a Convocation. National Academy of Science and National Academy of Engineering. Washington, D.C.: National Academy Press, May 1982.

Simpson, R. D. Relating Student Feelings to Achievement in Science. Washington, D.C.: National Science Teachers Association, 1978.

Stake, Robert, and J. Easley. Case Studies in Science Education, 2. Urbana: Center for Instructional Research and Curriculum Evaluation, Univ. of Illinois, Jan. 1978.

U.S. Congress. House. Committee on Science and Technology. The NSF and Pre-College Science Education: 1950-1975, Hearing, 94th Cong., 2nd Sess., Jan. 1975. Washington, D.C.: GPO, 1976.

Weiss, Iris. Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education. Washington, D.C.: National Science Foundation, March 1978.

Wellman, T. R. Science: A Basic for Language and Reading Development. Washington, D.C.: National Science Teachers Association, 1978.

Personal Interviews

Gerlovich, Jack. Personal interview. Des Moines, IA. 1 March 1983.

________. Personal interview. Des Moines, IA. 3 Oct. 1983.

________. Personal interview. Des Moines, IA. 9 Jan. 1984.

________. Personal interview. Des Moines, IA. 8 Feb. 1984.

________. Personal interview. Des Moines, IA. 29 March 1984.

________. Personal interview. Des Moines, IA. 20 April 1984.

Unruh, Roy. Personal interview. Cedar Falls, IA. 2 June 1983.

________. Personal interview. Storm Lake, IA. 30 Aug. 1983.

APPENDIX A

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APPENDIX C

ESTIMATED SUPPLY OF SECONDARY CHEMISTRY, PHYSICS,
MATH, BIOLOGY, GENERAL SCIENCE, AND EARTH
SCIENCE TEACHERS BY STATE 1980 - 1983

APPENDIX C

ESTIMATED SUPPLY OF SECONDARY CHEMISTRY, PHYSICS AND MATH TEACHERS BY STATE 1980 THROUGH 1983

STATE	Chemistry 1980	Chemistry 1981	Chemistry 1982	Chemistry 1983	Physics 1980	Physics 1981	Physics 1982	Physics 1983	Math 1980	Math 1981	Math 1982	Math 1983
Alabama	3	3.5	4	NR	5	5	5	NR	NR	4	NR	NR
Alaska	1	2	NR	3	1	2	NR	3	1	2	NR	3
Arizona	NR	4	3	3	NR	5	3	3	NR	4	3	4
Arkansas	4	4	4	4	4	4	4	4	4	4	5	4
California	2	4	4	4	4	4	4	3	2	4	4	5
Colorado	3.5	4	4	4	3.5	4	4	4	3.5	4	4	4
Connecticut	3	4	4	4	4	5	5	5	4	5	4	4
Delaware	3	3	4	3	3	4	4	3	3	4	4	4
District of Columbia	3	3	3	5	4	4	4	5	4	5	5	5
Florida	5	5	4	4	5	5	5	5	4	4	4	4
Georgia	1	3.5	4	4	1	4	4	4	1	5	5	5
Hawaii	4	4	4	4	4	5	5	5	3	4	4	4
Idaho	4	4	4	4	4	4	5	4	4	4	5	4
Illinois	5	5	4.5	5	5	5	5	5	5	5	5	5
Indiana	5	5	5	5	5	5	5	5	5	5	5	5
Iowa	5	4	4	4	5	5	5	5	5	5	5	5
Kansas	4	4	5	4	4	4	5	5	4	5	5	5
Kentucky	4	4	4	5	5	5	5	5	5	5	5	5
Louisiana	4	4	4	4	5	5	5	5	4	4	4	4
Maine	3.5	5	4.5	4	3.5	5	4.5	4	4	4	4.5	4
Maryland	4	4	4	4	4	4	5	5	4	5	5	5
Massachusetts	1	NR	3	NR	1	NR	3	NR	1	NR	3	NR
Michigan	4	NR	4	3	4	NR	5	4	4	NR	NR	4
Minnesota	3	3	4	3	4	4	4	3	NR	4	4	3
Mississippi	2	2	4	4	4	4	4	5	NR	3	4	5
Missouri	5	5	4	5	5	5	4	5	5	5	5	5
Montana	NR	NR	4	4	NR	NR	4	4	NR	NR	4	4
Nebraska	4	4	4	4	4	4	4	4.5	3	4	4	4.5
Nevada	4	4	5	4	5	5	5	4	4	4	5	5
New Hampshire	5	5	5	5	5	5	5	5	5	5	5	5
New Jersey	3.5	NR	NR	NR	4	NR	NR	NR	3	NR	NR	NR
New Mexico	3	NR	2	3	4	NR	2	4	4	NR	4	2
New York	4	4	5	4	5	5	5	5	5	5	5	4
North Carolina	5	4	4	5	5	5	5	5	5	5	4	5
North Dakota	4	4	5	3	4	4	5	4	4	4	5	4
Ohio	4	4	5	5	5	5	5	5	3	3	4	3
Oklahoma	4	4	5	3	5	5	4	3	5	4	4	4
Oregon	3	4	5	5	3	5	5	5	5	4	5	4
Pennsylvania	4	4	5	5	5	5	5	5	5	5	4	4
Rhode Island	NR	3	3	3	NR	3	3	3	NR	4	4	3
South Carolina	5	5	5	5	5	5	5	5	5	5	5	5
South Dakota	4	4	4	5	5	5	4	5	3	5	5	5
Tennessee	3.5	4	4	4	3.5	4	4	4	3.5	4	4	4
Texas	3	3	5	5	3	3	5	5	5	5	5	4
Utah	4	4	4	4	4	4	4	4	4	5	5	4
Vermont	4	5	4	4	5	5	5	5	3	4	4	4
Virginia	3	4	4	4	4	3	4	4	4	4	4	4
Washington	4	NR	4	4	4	NR	4	4	3.5	NR	4	4
West Virginia	5	4	NR	5	5	5	NR	5	5	4	NR	5
Wisconsin	4	4	4	3	5	5	5	3	5	4	4	3
Wyoming	4	3	3	3	4	3	3	3	4	4	4	3
American Samoa	5	5	5	NR	5	5	5	NR	5	4	4	NR
Puerto Rico	NR	4	5	5	NR	5	5	5	NR	3	NR	NR
TOTAL	182	186	208	200	203.5	209	221.5	212.5	180.5	201	205.5	201.5
MEAN	3.71	3.96	4.16	4.08	4.15	4.45	4.53	4.34	3.92	4.28	4.37	4.20

Rating Key: (1) Surplus, (2) Slight Surplus, (3) Adequate, (4) Shortage, (5) Critical Shortage
NR - No Response

APPENDIX C (continued)

ESTIMATED SUPPLY OF SECONDARY BIOLOGY, GENERAL SCIENCE AND EARTH SCIENCE TEACHERS BY STATE 1980 THROUGH 1983

	Biology				General Science				Earth Science			
STATE	1980	1981	1982	1983	1980	1981	1982	1983	1980	1981	1982	1983
Alabama	2	2	2	NR	3	3	3	NR	4	4	4	NR
Alaska	1	2	NR	3	1	2	NR	3	1	2	NR	3
Arizona	NR	3	3	3	NR	5	3	3	NR	3	3	3
Arkansas	3	3	3	3	3	3	4	4	3	3	4	3
California	2	3	4	4	3	3	4	4	4	4	4	3
Colorado	3	3	4	2	3.5	4	4	2	3.5	4	4	2
Connecticut	3	3	3	3	3	4	4	3	3	4	4	4
Delaware	3	1	2	2	3	1	1	2	3	1	2	3
District of Columbia	3	3	3	3	2	3	3	3	3	3	3	3
Florida	3	3	3	3	4	4	3	3	5	5	4	4
Georgia	1	2.5	3	3	1	5	4	4	1	4	3	3
Hawaii	2	3	3	4	3	3	3	3	4	4	4	4
Idaho	1	1	3	2	3	3	2	3	4	3	4	3
Illinois	3	3	3	3	4	4	3	4	4	4	3	4
Indiana	5	5	5	4	5	5	5	5	5	5	5	5
Iowa	2	2	2	2	3	3	4	3	4	4	4.5	4
Kansas	2	3	3	2	4	3	3	3	4	3	3	4
Kentucky	3	3	3	3	3	3	5	5	4	4	5	5
Louisiana	3	3	3	3	3	3	3	3	4	4	4	4
Maine	3	3	3	3	3.5	3	3.5	3	3.5	3	3.5	3.5
Maryland	3	2	3	2	4	4	4	5	4	4	5	5
Massachusetts	1	NR	1	NR	1	NR	1	NR	1	NR	1	NR
Michigan	3	NR	3.5	3	3	NR	3	3	3	NR	4	3
Minnesota	2	2	2	1	3	3	3	3	3	3	4	4
Mississippi	1	1	2	3	1	1	3	3	4	4	3	3
Missouri	4	4	4	4	4	4	4	4	4	4	4	5
Montana	NR	NR	4	4	NR	NR	4	3	NR	NR	3	3
Nebraska	3	3	3	3	3	3	3	3	4	3	4	4
Nevada	3	3	3	2	3	3	2	NR	3	3	4	3
New Hampshire	2	3	3	3	4	4	4	5	5	5	4	4
New Jersey	3	NR	NR	NR	3	NR	NR	NR	3	NR	NR	NR
New Mexico	2	NR	2	2	2	NR	2	1	3	NR	2	5
New York	3	3	3	3	3	3	3	4	4	4	4	4
North Carolina	4	2	1	3	4	3	4	4	4	5	5	4
North Dakota	3	3	4	2	4	NR	3	3	4	4	3	3
Ohio	2	3	3	3	3	3	3	4	2	3	3	4
Oklahoma	2	3	3	3	2	2	3	4	5	5	4	4
Oregon	3	2	4	3	3	3	4	3	3	4	5	5
Pennsylvania	2	1	1	2	2	1	3	3	4	5	5	4
Rhode Island	NR	3	1	2	NR	3	4	3	NR	3	NR	NR
South Carolina	4	4	4	4	4	3	3	4	5	5	5	5
South Dakota	3	3.5	3	3	3	3.5	3	3	3	3.5	3	4
Tenessee	3	2.5	3	3	3	2	2	3	4	4	4	3
Texas	2	1	1	1	4	5	NR	NR	5	5	5	4
Utah	3	3	3	3	3	3	3	3	4	4	4	3
Vermont	4	4	3	3	3	4	3	4	3	4	4	4
Virginia	1	1	2	1	2	1	2	1	5	4	5	5
Washington	3	NR	2	3	3	NR	3	3	4	NR	4	4
West Virginia	3	3	NR	5	4	4	NR	5	4	4	NR	5
Wisconsin	2	3	2	1	4	3	4	3	4	4	3	3
Wyoming	3	3	3	3	3	2	3	3	4	3	3	3
American Samoa	5	4	4	NR	5	5	4	NR	5	5	4	NR
Puerto Rico	NR	2	2	2	NR	2	1	3	NR	5	5	5
TOTAL	130	126.5	140.5	135	151	144.5	155.5	156	180	180.5	187	182.5
MEAN	2.65	2.69	2.81	2.75	3.08	3.14	3.27	3.32	3.67	3.84	3.82	3.90

Rating Key: (1) Surplus, (2) Slight Surplus, (3) Adequate, (4) Shortage, (5) Critical Shortage
NR No Response

APPENDIX D

SUMMARY OF THE NUMBER OF GRADUATES FROM THE TWENTY-SEVEN TEACHER EDUCATION INSTITUTIONS IN IOWA COMPLETING PREPARATION FOR A TEACHING CERTIFICATE WITH A BACHELOR DEGREE BY SUBJECT AREAS FOR THE YEARS: 1970-1982

Summary of the Number of Graduates from the Twenty-Seven Teacher Education Institutions in Iowa Completing Preparation for a Teaching Certificate with a Bachelor Degree by Subject Areas for the Years: 1970-1982

Subject Area: Science	Number of Graduates by Year												
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Combined*	57	56	29	24	60	61	77	71	56	42	49	35	18
Biology	137	129	107	119	84	77	66	66	61	52	36	59	41
Chemistry	17	15	19	17	16	13	11	16	13	7	5	8	6
Earth Science	0	0	0	0	7	4	12	6	7	2	3	1	2
General Science	43	40	16	34	7	7	7	14	5	12	5	16	15
Physical Science	0	0	0	0	9	14	7	11	8	0	0	6	3
Physics	15	15	19	18	9	9	7	6	5	2	2	3	2
Totals	269	255	190	212	192	185	187	190	155	117	100	128	87

*Refers to the "All Sciences" certification for Iowa.

APPENDIX E

SAMPLE TEACHER PRE- AND POST-QUESTIONNAIRES

Pre-Questionnaire (T)

School Name ______________________ City ____________________

What is the total student population of your district?

____

What is the total number of students enrolled in physics?

____

How many years have you taught? __________

How many years have you taught physics? __________

Approximately, how many semester hours of college physics have you taken?

0-3   3-9   9-20   20-36   36 or more

For the following, circle the letter(s) on the scale that best describes how comfortable you are, at this time, with teaching the concepts below. Interpret the scale to mean:

1 = Very Uncomfortable
2 = Uncomfortable
3 = Somewhat Uncomfortable
4 = Somewhat Comfortable
5 = Comfortable
6 = Very Comfortable

1.	Interpreting and analyzing relationships from graphs (including slopes and area under a curve).	1	2	3	4	5	6
2.	Plotting graphs from appropriate data.	1	2	3	4	5	6
3.	Making predictions from graphs.	1	2	3	4	5	6
4.	Solving mathematical problems related to concepts within physics.	1	2	3	4	5	6
5.	Collecting and organizing data.	1	2	3	4	5	6
6.	Using the metric system for measurements and calculations.	1	2	3	4	5	6
7.	Allowing the students the freedom to design and conduct their own experiments.	1	2	3	4	5	6
8.	Using the "Decision Making" process in relation to sociological and technological issues.	1	2	3	4	5	6

9.	Using the "Valuing" process in relation to sociological and technological issues	1	2	3	4	5	6
10.	Presenting the concepts involved in Kinematics.	1	2	3	4	5	6
11.	Presenting the concepts involved in Force.	1	2	3	4	5	6
12.	Presenting the concepts involved in Dynamics.	1	2	3	4	5	6
13.	Presenting the concepts involved in Work and Energy.	1	2	3	4	5	6
14.	Presenting the concepts involved in Internal Energy and Heat.	1	2	3	4	5	6
15.	Presenting the concepts involved in Wave Phenomena and Light.	1	2	3	4	5	6
16.	Presenting the concepts involved in Electricity and Magnetism.	1	2	3	4	5	6
17.	Presenting the concepts involved in Atomic and Nuclear Physics.	1	2	3	4	5	6

For the remaining statements circle the letter(s) that best describe your view at this time. For interpretation of the scale, use the following as a guide:

1 = Strongly Disagree
2 = Disagree
3 = Disagree Somewhat
4 = Agree Somewhat
5 = Agree
6 = Strongly Agree

18.	Laboratory activities should be an important part of the physics program.	1	2	3	4	5	6
19.	This program will help to improve my skills and abilities in regard to teaching physics.	1	2	3	4	5	6
20.	This program will increase the students' awareness about career choices in the physical sciences.	1	2	3	4	5	6

21.	This program will have a positive effect on my attitude towards physics.	1	2	3	4	5	6
22.	This program will have a positive effect on the students' attitude towards the physics curriculum.	1	2	3	4	5	6
23.	The learning cycle format (exploration, concept, introduction, application) is an important process for teaching physics.	1	2	3	4	5	6
24.	This program will increase the students confidence in laboratory activities.	1	2	3	4	5	6
25.	This physics program will help the students to understand the current sociological and technological issues.	1	2	3	4	5	6
26.	This physics program will help to improve my skills and abilities in using the laboratory equipment.	1	2	3	4	5	6
27.	Computers would be an effective teaching aid for this physics program.	1	2	3	4	5	6
28.	This program will increase the number of students enrolling in physics.	1	2	3	4	5	6
29.	This particular program will require more preparation time.	1	2	3	4	5	6

Post-Physics Questionnaire (T)

School Name ______________________ City ________________

For the following, circle the letter(s) on the scale that best describes how comfortable you are, at this time, with teaching the concepts below. Interpret the scale to mean:

1 = Very Uncomfortable
2 = Uncomfortable
3 = Somewhat Uncomfortable
4 = Somewhat Comfortable
5 = Comfortable
6 = Very Comfortable

1.	Interpreting and analyzing relationships from graphs (including slopes and area under a curve).	1 2 3 4 5 6
2.	Plotting graphs from appropriate data.	1 2 3 4 5 6
3.	Making predictions from graphs.	1 2 3 4 5 6
4.	Solving mathematical problems related to concepts within physics.	1 2 3 4 5 6
5.	Collecting and organizing data.	1 2 3 4 5 6
6.	Using the metric system for measurements and calculations.	1 2 3 4 5 6
7.	Allowing the students the freedom to design and conduct their own experiments.	1 2 3 4 5 6
8.	Using the "Decision Making" process in relation to sociological and technological issues.	1 2 3 4 5 6
9.	Using the "Valuing" process in relation to sociological and technological issues	1 2 3 4 5 6
10.	Presenting the concepts involved in Kinematics.	1 2 3 4 5 6
11.	Presenting the concepts involved in Force.	1 2 3 4 5 6
12.	Presenting the concepts involved in Dynamics.	1 2 3 4 5 6

13. Presenting the concepts involved in Work and Energy. 1 2 3 4 5 6

14. Presenting the concepts involved in Internal Energy and Heat. 1 2 3 4 5 6

15. Presenting the concepts involved in Wave Phenomena and Light. 1 2 3 4 5 6

16. Presenting the concepts involved in Electricity and Magnetism. 1 2 3 4 5 6

17. Presenting the concepts involved in Atomic and Nuclear Physics. 1 2 3 4 5 6

For the remaining statements circle the letter(s) that best describe your view at this time. For interpretation of the scale, use the following as a guide:

1 = Strongly Disagree
2 = Disagree
3 = Disagree Somewhat
4 = Agree Somewhat
5 = Agree
6 = Strongly Agree

18. Laboratory activities should be an important part of the physics program. 1 2 3 4 5 6

19. This program will help to improve my skills and abilities in regard to teaching physics. 1 2 3 4 5 6

20. This program will increase the students' awareness about career choices in the physical sciences. 1 2 3 4 5 6

21. This program will have a positive effect on my attitude towards physics. 1 2 3 4 5 6

22. This program will have a positive effect on the students' attitude towards the physics curriculum. 1 2 3 4 5 6

23. The learning cycle format (exploration, concept, introduction, application) is an important process for teaching physics. 1 2 3 4 5 6

24. This program will increase the students confidence in laboratory activities.	1	2	3	4	5	6
25. This physics program will help the students to understand the current sociological and technological issues.	1	2	3	4	5	6
26. This physics program will help to improve my skills and abilities in using the laboratory equipment.	1	2	3	4	5	6
27. Computers would be an effective teaching aid for this physics program.	1	2	3	4	5	6
28. This program will increase the number of students enrolling in physics.	1	2	3	4	5	6
29. This particular program will require more preparation time.	1	2	3	4	5	6

APPENDIX F

SAMPLE ADMINISTRATOR PRE- AND POST-QUESTIONNAIRES

Pre-Physics Questionnaire (A)

School Name ____________________ City ______________

In responding to the following statements circle the number that best expresses your present view on each item. For interpretation of the scale, use the following:

1 = Strongly Disagree
2 = Disagree
3 = Disagree Somewhat
4 = Agree Somewhat
5 = Agree
6 = Strongly Agree

1.	This program will help to upgrade my teacher's ability to teach physics.	1	2	3	4	5	6
2.	Laboratory activities should be an important part of a physics program.	1	2	3	4	5	6
3.	This program will help the students to understand the current sociological and technological issues.	1	2	3	4	5	6
4.	The learning cycle format (exploration, concept, introduction, application) will be an important process for teaching physics.	1	2	3	4	5	6
5.	This program will increase the number of students enrolling in physics.	1	2	3	4	5	6
6.	My teacher has expressed a confident attitude toward being a part of this program.	1	2	3	4	5	6
7.	This program will have a positive effect on my own attitude towards physics.	1	2	3	4	5	6
8.	This type of program will increase student confidence in laboratory activities.	1	2	3	4	5	6
9.	My teacher does have the skills and abilities required when utilizing the laboratory equipment.	1	2	3	4	5	6
10.	Computers would be an effective teaching aid for this physics program.	1	2	3	4	5	6

11. This program will increase the student's awareness about career choices in the physical sciences.	1	2	3	4	5	6
12. This type of program will have a positive effect on the student's attitude towards the physics curriculum.	1	2	3	4	5	6
13. This type of program will require more teacher preparation time.	1	2	3	4	5	6
14. This program will change the way my school district views teacher shortages in critical areas of education.	1	2	3	4	5	6
15. This type of program may cause the school district to provide more financial support for physics instruction.	1	2	3	4	5	6

Post-Physics Questionnaire (A)

School Name ______________________ City ________________

In responding to the following statements circle the number that best expresses your present view on each item. For interpretation of the scale, use the following:

1 = Strongly Disagree
2 = Disagree
3 = Disagree Somewhat
4 = Agree Somewhat
5 = Agree
6 = Strongly Agree

1.	This program will help to upgrade my teacher's ability to teach physics.	1	2	3	4	5	6
2.	Laboratory activities should be an important part of a physics program.	1	2	3	4	5	6
3.	This program will help the students to understand the current sociological and technological issues.	1	2	3	4	5	6
4.	The learning cycle format (exploration, concept, introduction, application) will be an important process for teaching physics.	1	2	3	4	5	6
5.	This program will increase the number of students enrolling in physics.	1	2	3	4	5	6
6.	My teacher has expressed a confident attitude toward being a part of this program.	1	2	3	4	5	6
7.	This program will have a positive effect on my own attitude towards physics.	1	2	3	4	5	6
8.	This type of program will increase student confidence in laboratory activities.	1	2	3	4	5	6
9.	My teacher does have the skills and abilities required when utilizing the laboratory equipment.	1	2	3	4	5	6
10.	Computers would be an effective teaching aid for this physics program.	1	2	3	4	5	6

11.	This program will increase the student's awareness about career choices in the physical sciences.	1	2	3	4	5	6
12.	This type of program will have a positive effect on the student's attitude towards the physics curriculum.	1	2	3	4	5	6
13.	This type of program will require more teacher preparation time.	1	2	3	4	5	6
14.	This program will change the way my school district views teacher shortages in critical areas of education.	1	2	3	4	5	6
15.	This type of program may cause the school district to provide more financial support for physics instruction.	1	2	3	4	5	6

APPENDIX G

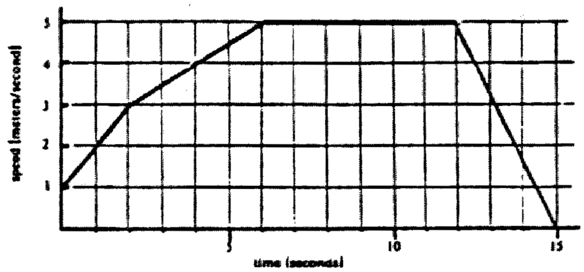
SAMPLE TEACHER PRE- AND POST-ASSESSMENT FORMS

Pre-Physics Assessment Form

School Name ______________________________ City ______________________________

DIAGRAM FOR QUESTIONS 1, 2, and 3

The graph Below Represents the Motion of an Object Traveling in a Straight Line.



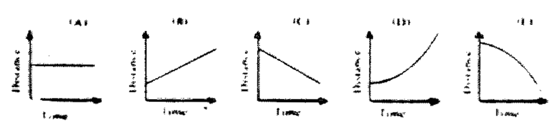
1. The acceleration of the object between times t = 2 second and t = 6 seconds is
   (A) 0.5 meters/second^2.
   (B) 0.7 meters/second^2.
   (C) 0.9 meters/second^2.
   (D) 1.0 meters/second^2.
   (E) 4.5 meters/second^2.

2. Between times t = 6 seconds and t =]2 seconds the object travelled
   (A) zero.
   (B) 10 meters.
   (C) 30 meters.
   (D) 45 meters.
   (E) 57.5 meters.

3. The average speed of the object for the first 6 seconds is
   (A) 0.5 meters/second.
   (B) 2.5 meters/second.
   (C) 3.0 meters/second.
   (D) 3.3 meters/second.
   (E) 5.0 meters/second.

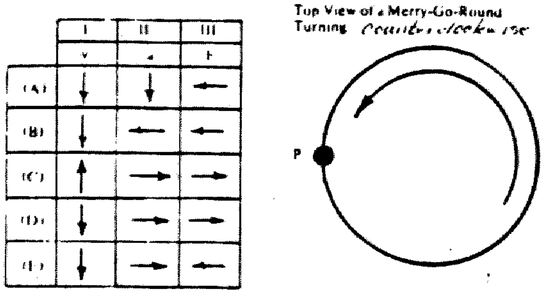
DIAGRAM FOR QUESTION 4

Distance Versus Time Graphs



4. The one graph above which illustrates motion in a straight line with positive acceleration is
   (A) A.
   (B) B.
   (C) C.
   (D) D.
   (E) E.

DIAGRAM FOR QUESTION 5



5. A student is riding a constant speed merry-g-round, as shown above. When the student is at point P, the set of vectors shows the direction of the student's

   I. velocity v.
   II. acceleration a. and
   III. centripetal force F.

   (A) A.
   (B) B.
   (C) C.
   (D) D.
   (E) E.

6. Force can be thought of as the

   (A) energy used to move an object.
   (B) mass of an object.
   (C) momentum of an object.
   (D) quantity that changes the velocity of an object.
   (E) quantity that keeps an object moving.

7. If the speed of an object moving in a straight line is increasing at a constant rate, the net force acting on the object is

   (A) constant, but not zero.
   (B) decreasing at a constant rate.
   (C) increasing at a constant rate.
   (D) zero.
   (E) none of the above.

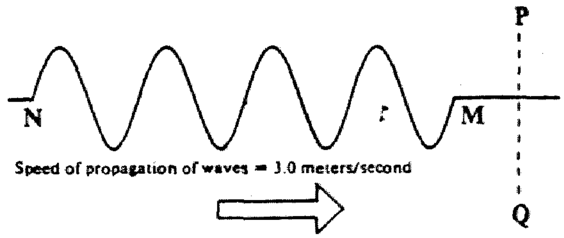
8. Energy is to joule as power is to

   (A) joule-second.
   (B) kilowatt-hour.
   (C) newton.
   (D) newton-meter.
   (E) watt.

9. Two stationary bodies attract each other with a gravitational force of 5.0×10^{-12} newtons. If the mass of each body is tripled, the force will now be

   (A) 1.5×10^{-12} newtons.
   (B) 3.0×10^{-11} newtons.
   (C) 4.5×10^{-11} newtons.
   (D) 2.1×10^{-10} newtons.
   (E) 4.1×10^{-10} newtons.

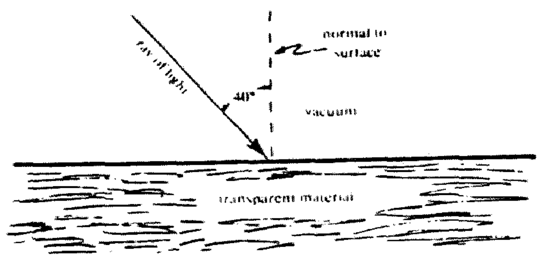
DIAGRAM FOR QUESTION 10



10. Waves are traveling with a speed of 3.0 meters/second toward line PQ as shown in the diagram above. If the entire set of waves MN passes the line PQ in one second, the wavelength of these waves is

    (A) 0.75 meters.
    (B) 1.5 meters.
    (C) 3.0 meters.
    (D) 6.0 meters.
    (E) 12 meters.

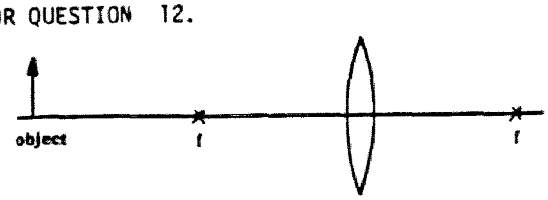
DIAGRAM FOR QUESTION 11



11. A ray of light, initially traveling in a vacuum, is incident on the surface of a flat transparent material as shown in the diagram above. Part of the light is reflected at the surface and part is refracted. The angle between the reflected ray and the refracted ray is

    (A) less than 40°.
    (B) between 40° and 50°.
    (C) between 50° and 100°.
    (D) between 100° and 140°.
    (E) more than 140°.

DIAGRAM FOR QUESTION 12.



Thin Converging Lens

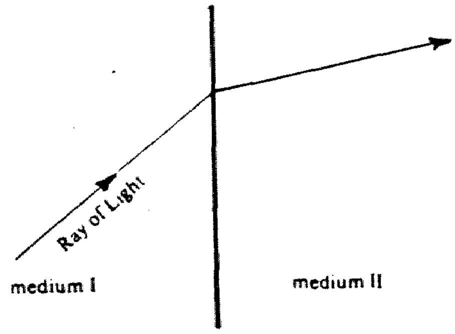
12. An object is placed two focal lengths from a thin converging lens. The magnification of the resulting image is

    (A) one-fourth.
    (B) one-half.
    (C) one.
    (D) two.
    (E) four.

13. An object is placed 30 centimeters from a thin converging lens with a focal length of 10 centimeters. The image will be described as

(A) real and 7.4 centimeters from the lens.
(B) real and 15 centimeters from the lens.
(C) real and 30 centimeters from the lens.
(D) virtual and 7.5 centimeters from the lens.
(E) virtual and 15 centimeters from the lens.

DIAGRAM FOR QUESTION 14.



14. Monochromatic light follows the path shown in the diagram above. Compared with the light in medium I, the light in medium II has a

(A) greater intensity.
(B) higher frequency.
(C) higher speed.
(D) lower frequency.
(E) lower speed.

15. "Light is believed to act like a wave." The experimental observation which provides the best support for the quoted statement is

(A) light can be reflected by a mirror.
(B) light forms light and dark bands after passing through a narrow slit.
(C) light is bent by a gravitational field.
(D) light is scattered when passing through smoke.
(E) white light can be broken into its component colors by a prism.

16. The one example of waves which <u>cannot</u> be polarized is

(A) light.
(B) microwaves.
(C) radio waves.
(D) sound waves.
(E) standing waves on a string.

17. The kilocalorie is the amount of energy needed to raise the temperature of one

(A) gram of water by 1 Fahrenheit degree.
(B) kilogram of water by 1 Celsius degree.
(C) kilogram of water by 1 Fahrenheit degree.
(D) pound of water by 1 Celsius degree.
(E) pound of water by 1 Fahrenheit degree.

18. A kilogram of pure steam at 100° Celsius is condensed to water at 100° Celsius and then is cooled to 80° Celsius. The heat of vaporization for water at 100° is 540 kilocalories/kilogram. The heat energy given off in this process is

(A) 80 kilocalories.
(B) 100 kilocalories.
(C) 520 kilocalories.
(D) 540 kilocalories.
(E) 560 kilocalories.

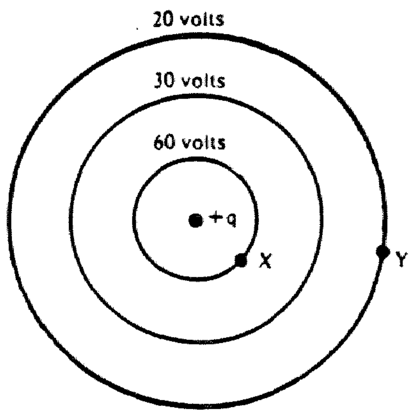
19. One hundred grams of ice at 0° Celsius is added to 400 grams of water at 16° Celsius in a beaker. Assume no heat energy is lost to or gained from the beaker or other surroundings. If the heat of fusion of water is 80 calories per gram, the final equilibrium temperature of the mixture is

    (A) -4.0° Celsius
    (B) -1.6° Celsius
    (C) 0° Celsius
    (D) 1.6° Celsius
    (E) 4.0° Celsius

20. In general, a positively charged electroscope

    (A) has fewer electrons than protons.
    (B) has more electrons than protons.
    (C) has no protons.
    (D) has the same number of protons as electrons.
    (E) repels a negatively charged object.

DIAGRAM FOR QUESTION 21



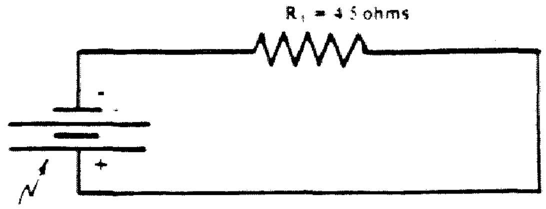
21. In the diagram above, circular equipotential lines are drawn at 60 volts, 30 volts and 20 volts about an electric charge +q. The total work done in moving an object with a charge of 10 coulombs from position Y to position X is

    (A) zero.
    (B) 40 joules.
    (C) 110 joules.
    (D) 200 joules.
    (E) 400 joules.

22. Gravitational and electrical forces are similar in the sense that for point objects or spherical distributions both are

    (A) always attractive and strong.
    (B) always attractive and weak.
    (C) directly proportional to the square of the distance of separation.
    (D) inversely proportional to the distance of separation.
    (E) inversely proportional to the square of the distance of separation.

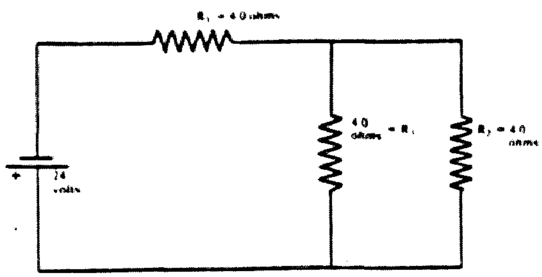
DIAGRAM FOR QUESTION 23



23. The current through resistor R_1 in the diagram above is

(A) 2.0 amperes.
(B) 4.0 amperes.
(C) 6.0 amperes.
(D) 18 amperes.
(E) 12 amperes.

DIAGRAM FOR QUESTION 24



24. The total resistance of the circuit shown above is

(A) 2.0 ohms.
(B) 4.0 ohms.
(C) 6.0 ohms.
(D) 8.0 ohms.
(E) 12 ohms.

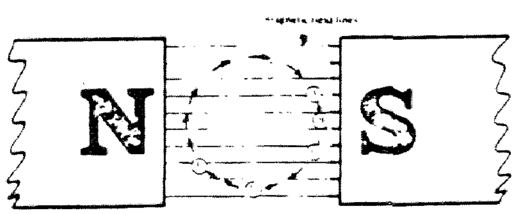
25. The magnetic force experience by a moving charged particle depends upon

1. the magnetic field strength.
2. the particle's charge.
3. the particle's velocity.

(A) 1 only.
(B) 1 & 2 only.
(C) 1 & 3 only.
(D) 1, 2, and 3.
(E) 2 & 3 only.

DIAGRAM FOR QUESTION 26.

The diagram below shows a wire which is perpendicular to the page, moving in a circular path. The magnetic field between the N and S poles is uniform and the speed of the wire is constant. The letters A, B, C, D, and E show positions of the wire.



26. The induced emf (that is, voltage) in the wire is a minimum when the wire is at position

(A) A.
(B) B.
(C) C.
(D) D.
(E) E.

27. The type of radiation having the greatest energy per photon is

(A) gamma.
(B) infrared.
(C) microwave.
(D) ultraviolet.
(E) visible.

DIAGRAM FOR QUESTION 28

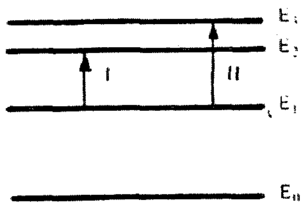


Diagram of the energy levels for an atom

28. Transition I in the drawing above represents absorption of a photon of blue light. Transition II could represent absorption of

(A) green light.
(B) infrared radiation.
(C) radio waves.
(D) ultraviolet radiation.
(E) none of the above.

29. Radium ($^{225}_{88}$Ra) undergoes negative beta decay. The daughter nucleus is

(A) $^{225}_{88}$Ra.

(B) $^{224}_{89}$Ac.

(C) $^{225}_{89}$Ac.

(D) $^{225}_{87}$Fr.

(E) $^{226}_{88}$Ra.

30. A radioactive sample has a half-life of nine months. The fraction of the original activity remaining after three years is

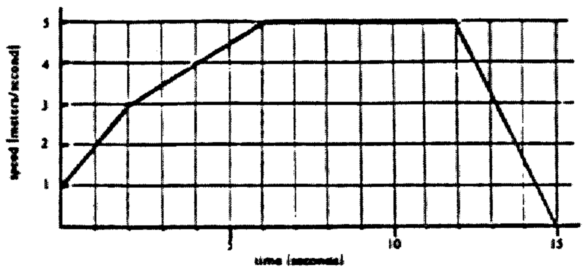
(A) 1/2.
(B) 1/4.
(C) 1/8.
(D) 1/16.
(E) 1/32.

Post-Physics Assessment Form

School Name ______________________ City ______________________

DIAGRAM FOR QUESTIONS 1, 2, and 3

The graph Below Represents the Motion of an Object Traveling in a Straight Line.



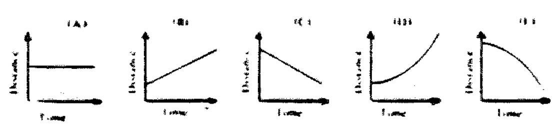
1. The acceleration of the object between times t = 2 second and t = 6 seconds is
   (A) 0.5 meters/second^2.
   (B) 0.7 meters/second^2.
   (C) 0.9 meters/second^2.
   (D) 1.0 meters/second^2.
   (E) 4.5 meters/second^2.

2. Between times t = 6 seconds and t =]2 seconds the object travelled
   (A) zero.
   (B) 10 meters.
   (C) 30 meters.
   (D) 45 meters.
   (E) 57.5 meters.

3. The average speed of the object for the first 6 seconds is
   (A) 0.5 meters/second.
   (B) 2.5 meters/second.
   (C) 3.0 meters/second.
   (D) 3.3 meters/second.
   (E) 5.0 meters/second.

DIAGRAM FOR QUESTION 4

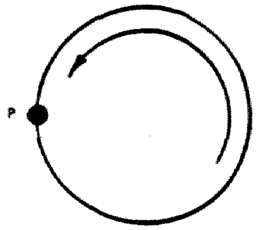
Distance Versus Time Graphs



4. The one graph above which illustrates motion in a straight line with positive acceleration is
   (A) A.
   (B) B.
   (C) C.
   (D) D.
   (E) E.

DIAGRAM FOR QUESTION 5

	I	II	III
	v	a	F
(A)	↓	↓	←
(B)	↓	←	←
(C)	↑	→	→
(D)	↓	→	→
(E)	↓	→	←



5. A student is riding a constant speed merry-g-round, as shown above. When the student is at point P, the set of vectors shows the direction of the student's

   I. velocity v.
   II. acceleration a. and
   III. centripetal force F.

   (A) A.
   (B) B.
   (C) C.
   (D) D.
   (E) E.

6. Force can be thought of as the

   (A) energy used to move an object.
   (B) mass of an object.
   (C) momentum of an object.
   (D) quantity that changes the velocity of an object.
   (E) quantity that keeps an object moving.

7. If the speed of an object moving in a straight line is increasing at a constant rate, the net force acting on the object is

   (A) constant, but not zero.
   (B) decreasing at a constant rate.
   (C) increasing at a constant rate.
   (D) zero.
   (E) none of the above.

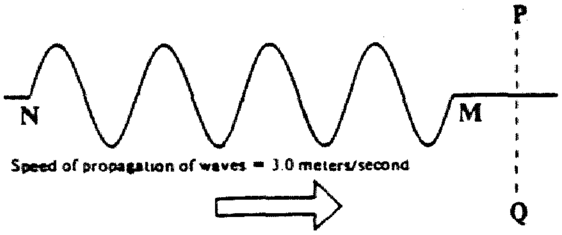
8. Energy is to joule as power is to

   (A) joule-second.
   (B) kilowatt-nour.
   (C) newton.
   (D) newton-meter.
   (E) watt.

9. Two stationary bodies attract each other with a gravitational force of 5.0×10^{-12} newtons. If the mass of each body is tripled, the force will now be

   (A) 1.5×10^{-12} newtons.
   (B) 3.0×10^{-11} newtons.
   (C) 4.5×10^{-11} newtons.
   (D) 2.1×10^{-10} newtons.
   (E) 4.1×10^{-10} newtons.

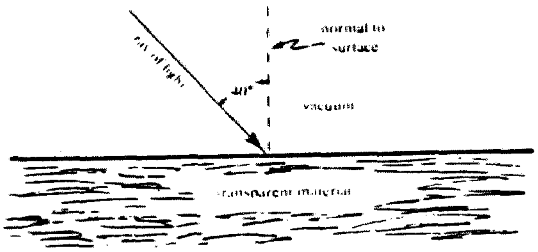
DIAGRAM FOR QUESTION 10



10. Waves are traveling with a speed of 3.0 meters/second toward line PQ as shown in the diagram above. If the entire set of waves MN passes the line PQ in one second, the wavelength of these waves is

(A) 0.75 meters.
(B) 1.5 meters.
(C) 3.0 meters.
(D) 6.0 meters.
(E) 12 meters.

DIAGRAM FOR QUESTION 11



11. A ray of light, initially traveling in a vacuum, is incident on the surface of a flat transparent material as shown in the diagram above. Part of the light is reflected at the surface and part is refracted. The angle between the reflected ray and the refracted ray is

(A) less than 40°.

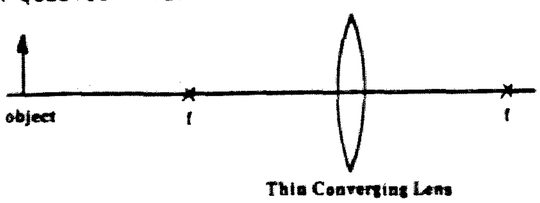
(B) between 40° and 50°.

(C) between 50° and 100°.

(D) between 100° and 140°.

(E) more than 140°.

DIAGRAM FOR QUESTION 12.



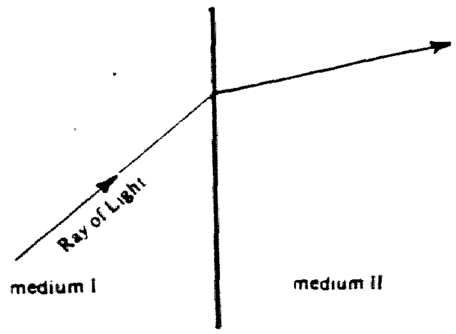
12. An object is placed two focal lengths from a thin converging lens. The magnification of the resulting image is

(A) one-fourth.
(B) one-half.
(C) one.
(D) two.
(E) four.

13. An object is placed 30 centimeters from a thin converging lens with a focal length of 10 centimeters. The image will be described as

    (A) real and 7.4 centimeters from the lens.
    (B) real and 15 centimeters from the lens.
    (C) real and 30 centimeters from the lens.
    (D) virtual and 7.5 centimeters from the lens.
    (E) virtual and 15 centimeters from the lens.

DIAGRAM FOR QUESTION 14.



14. Monochromatic light follows the path shown in the diagram above. Compared with the light in medium I, the light in medium II has a

    (A) greater intensity.
    (B) higher frequency.
    (C) higher speed.
    (D) lower frequency.
    (E) lower speed.

15. "Light is believed to act like a wave." The experimental observation which provides the best support for the quoted statement is

    (A) light can be reflected by a mirror.
    (B) light forms light and dark bands after passing through a narrow slit.
    (C) light is bent by a gravitational field.
    (D) light is scattered when passing through smoke.
    (E) white light can be broken into its component colors by a prism.

16. The one example of waves which <u>cannot</u> be polarized is

    (A) light.
    (B) microwaves.
    (C) radio waves.
    (D) sound waves.
    (E) standing waves on a string.

17. The kilocalorie is the amount of energy needed to raise the temperature of one

    (A) gram of water by 1 Fahrenheit degree.
    (B) kilogram of water by 1 Celsius degree.
    (C) kilogram of water by 1 Fahrenheit degree.
    (D) pound of water by 1 Celsius degree.
    (E) pound of water by 1 Fahrenheit degree.

18. A kilogram of pure steam at 100° Celsius is condensed to water at 100° Celsius and then is cooled to 80° Celsius. The heat of vaporization for water at 100° is 540 kilocalories/kilogram. The heat energy given off in this process is

    (A) 80 kilocalories.
    (B) 100 kilocalories.
    (C) 520 kilocalories.
    (D) 540 kilocalories.
    (E) 560 kilocalories.

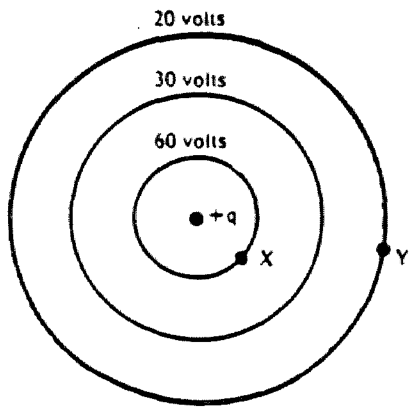
19. One hundred grams of ice at 0° Celsius is added to 400 grams of water at 16° Celsius in a beaker. Assume no heat energy is lost to or gained from the beaker or other surroundings. If the heat of fusion of water is 80 calories per gram, the final equilibrium temperature of the mixture is

    (A) -4.0° Celsius
    (B) -1.6° Celsius
    (C) 0° Celsius
    (D) 1.6° Celsius
    (E) 4.0° Celsius

20. In general, a positively charged electroscope

    (A) has fewer electrons than protons.
    (B) has more electrons than protons.
    (C) has no protons.
    (D) has the same number of protons as electrons.
    (E) repels a negatively charged object.

DIAGRAM FOR QUESTION 21



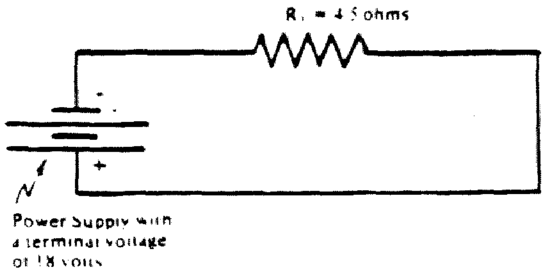
21. In the diagram above, circular equipotential lines are drawn at 60 volts, 30 volts and 20 volts about an electric charge +q. The total work done in moving an object with a charge of 10 coulombs from position Y to position X is

    (A) zero.
    (B) 40 joules.
    (C) 110 joules.
    (D) 200 joules.
    (E) 400 joules.

22. Gravitational and electrical forces are similar in the sense that for point objects or spherical distributions both are

    (A) always attractive and strong.
    (B) always attractive and weak.
    (C) directly proportional to the square of the distance of separation.
    (D) inversely proportional to the distance of separation.
    (E) inversely proportional to the square of the distance of separation.

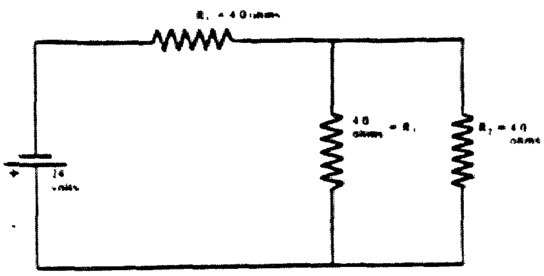
DIAGRAM FOR QUESTION 23



23. The current through resistor R_1 in the diagram above is

    (A) 2.0 amperes.
    (B) 4.0 amperes.
    (C) 6.0 amperes.
    (D) 18 amperes.
    (E) 12 amperes.

DIAGRAM FOR QUESTION 24



24. The total resistance of the circuit shown above is

    (A) 2.0 ohms.
    (B) 4.0 ohms.
    (C) 6.0 ohms.
    (D) 8.0 ohms.
    (E) 12 ohms.

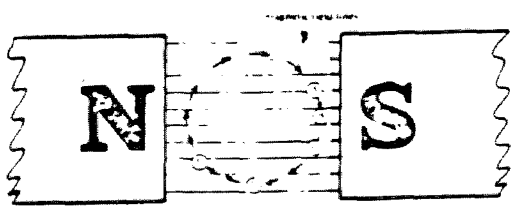
25. The magnetic force experience by a moving charged particle depends upon

    1. the magnetic field strength.
    2. the particle's charge.
    3. the particle's velocity.

    (A) 1 only.
    (B) 1 & 2 only.
    (C) 1 & 3 only.
    (D) 1, 2, and 3.
    (E) 2 & 3 only.

DIAGRAM FOR QUESTION 26.

The diagram below shows a wire which is perpendicular to the page, moving in a circular path. The magnetic field between the N and S poles is uniform and the speed of the wire is constant. The letters A, B, C, D, and E show positions of the wire.



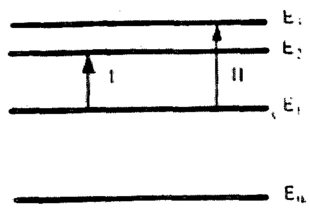
26. The induced emf (that is, voltage) in the wire is a minimum when the wire is at position

(A) A.
(B) B.
(C) C.
(D) D.
(E) E.

27. The type of radiation having the greatest energy per photon is

(A) gamma.
(B) infrared.
(C) microwave.
(D) ultraviolet.
(E) visible.

DIAGRAM FOR QUESTION 28



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APPENDIX H

SAMPLE DIRECTIONS AND FORMULAS FOR TEACHER ASSESSMENT INSTRUMENTS

DIRECTIONS

In responding to the following assessment form please use the information below:

1. Answer each and every item.
2. Respond by circling the letter that you feel will answer the question or statement.
3. Respond only once to each item.
4. When you have finished, return all materials to the administrator.

You will notice that we have included a sheet that contains many of the formulas and constants that could be used in the physics assessment. Feel free to use those that you need, and use the back side as a scratch sheet.

Before you turn your form into the administrator check to make sure that your school and city names are on the front page.

THANK YOU!

Physics Formulas and Constants

$v = \Delta s/t$

$a = \Delta v/t$

$F = ma$

$F_g = \frac{Gm_1m_2}{d^2}$

$v = f\lambda$

$n = \frac{\sin\theta_i}{\sin\theta_r}$

$1/f = 1/d_i + 1/d_o$

$d_i/d_o = h_i/h_o$

$\frac{\sin\theta_1}{\sin\theta_2} = v_1/v_2$

$\Delta H = mc\Delta T$

$L_f = 80$ cal/g

$L_v = 540$ cal/g

$C_{H_2O} = 1$ cal/g/c^0

$F_e = \frac{k\, q_1q_2}{d^2}$

$V = W/q$

$V = IR$

$F_m = Bqv$

$G = 6.67 \times 10^{-11}$ N m^2/kg^2

$g = 9.8$ m/s^2

$Q_e = 1.6 \times 10^{-19}$C

$M_e = 9.1 \times 10^{-31}$ kg

$E = mc^2$

$P = I^2R = E/t$

$KE = 1/2\ mv^2$

$F_c = mv^2/r = \frac{4\pi^2 mr}{T^2}$

APPENDIX I

DPI INSERVICE LOCATIONS

Pre-Assessment Locations

August 30, 1983
AEA's 3, 4, 5, and 12
Buena Vista College
Storm Lake, Iowa

August 31, 1983
AEA's 13 and 14
Holiday Inn
Red Oak, Iowa

September 1, 1983
AEA's 9, 15, and 16
Iowa Wesleyan College
Mt. Pleasant, Iowa

September 7, 1983
AEA's 6 and 11
Heartland AEA
Ankeny, Iowa

September 8, 1983
AEA's 1, 2, 7, and 10
AEA 7
Waterloo, Iowa

Post-Assessment Location

April 12, 1984
AEA's 1, 2, 3, 4, 5, 6, 7,
9, 10, 11, 12, 13, 14, 15 and 16
Heartland AEA
Ankeny, Iowa

APPENDIX J

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR MAJOR STUDY VARIABLES

Appendix J

Pearson Product-Moment Correlation Coefficients
for Major Study Variables(N=29)

	TYRS	PYRS	DSIZE	PHYTAK	KNOWPRE	KNOWPOST	COMPRE	COMPOST	TATTPRE	TATTPOST	AATTPRE	AATTPOST	KNOWGAIN	AATTGAIN
PYRS	.59**													
DSIZE	.041	.112												
PHYTAK	.057	.373*	.059											
KNOWPRE	.435*	.474**	.359*	.404*										
KNOWPOST	.284	.259	.358*	.253	.794**									
COMPRE	.036	.301	.299	.421*	.463**	.198								
COMPOST	.108	.116	.106	.293	.345*	.051	.708*							
TATTPRE	.15	.253	.109	.260	.137	.211	.220	.061						
TATTPOST	.005	.032	.018	.357*	.201	.205	.304	.193	.438**					
AATTPRE	.092	.179	.410*	.190	.102	.390*	.225	.202	.061	.138				
AATTPOST	.025	.203	.388*	.072	.162	.064	.175	.168	.455**	.656**	.398*			
KNOWGAIN	.308	.407*	.041	.301	.507**	.120	.475**	.491	.075	.036	.384*	.174		
AATTGAIN	.083	.109	.165	.193	.236	.307	.05	.057	.451**	.788**	.183	.828**	.048	
TATTGAIN	.107	.155	.101	.186	.111	.061	.159	.160	.282	.738**	.193	358*	.096	.052**

*p .05
**p .01